FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

IN THIS ISSUE

The Detection and Quantitative Determination of Coloring Materials in Butter and Margarine / *367*

Effect of Fluctuating Temperatures on Frozen Turkeys / *372*

Development of a New Concept for Processing Fruit Jelly / *377*

The Use of Fresh Fruit Objective Tests to Predict the Quality of Canned Italian Prunes / *381*

Comparative Sensitivity of Rating Scale and Paired Comparison Methods for Measuring Consumer Preference / *385*

Preparation of Tasty Vegetable Products by Deep-Fat Frying / *388*

Estimation of Free Starch in Potato Granules and Its Relation to Consistency of Reconstituted Product / *393*

Maturity Indices in Lima Beans / *395*

Amending the Federal Food, Drug, and Cosmetic Act / *398*

Freeze-Dried Meat. I. Preparation and Properties / *401*

Antibiotics in Animal Nutrition / *405*

Temperatures in Relation to Deciduous Fruit Production / *409*

Inhibition of Mold and Yeast Development in Fish Products / *411*

The Value of Dehydrated Vegetables as a Supplement to the Proteins in Milled Wheat Flour and Corn Meal / *413*

The Food Engineer and Food Industry Profits / *415*

Pediatric Food Problems / *417*

Affairs of the Institute / *4*

It's St. Louis in 1956

SIXTEENTH ANNUAL MEETING OF IFT

Pages 367-418

August, 1955 Volume 9, Number 8

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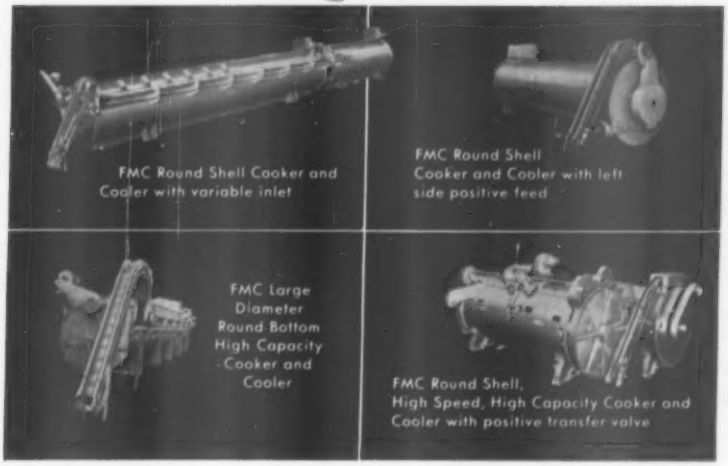

FMC Round Shell Cooker and Cooler with variable inlet

FMC Round Shell Cooker and Cooler with left side positive feed

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FMC Round Shell, High Speed, High Capacity Cooker and Cooler with positive transfer valve

You can expect a long and profitable life from this FMC equipment: it's extra-heavy constructed for best results

Now you can choose from several types of FMC Continuous Atmospheric Cookers and Coolers for processing foods where high-temperatures (over 212° F) are not required.

Steam flow tests prove that steam consumption is substantially lower than that required for equivalent retort operations. In addition, multiple can-handling operations are eliminated, and one man is able to control a battery of these FMC units!

Other famous FMC features include the special "Spiral-Reel" design; precision construction with extra-heavy welded steel plates for durability, and a selection of several types of gravity and positive feed type elevators.

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Gives foods true, natural yellow color and vitamin A potency

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Beta carotene 'Roche' has many advantages:

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Beta carotene is the natural coloring matter of butter and other dairy products and is a constituent of cereal grains, alfalfa, carrots, and other vegetation. 'Roche' beta carotene imparts a *true* natural yellow color without any tinge of green. It does not change to a reddish color as do some vegetable pigments during storage.

ADDS NUTRITIONAL VALUE

Theoretically, one gram of pure beta carotene is equivalent to 1.67 million U.S.P. units of vitamin A. High retention of beta carotene-vitamin A activity is achieved in baked goods and other foods when margarine and shortening containing added beta carotene 'Roche' are used.

COLOR STABILITY

Extensive laboratory data show excellent color stability of margarine, butter, shortening, cheese, edible oils and yellow bakery products which were colored with beta carotene 'Roche.'

UNIFORMITY

The high degree of purity and color stability ensures uniform and constant intensity of color when using equal amounts per batch.

USAGE

Beta carotene 'Roche' is ideal for use in the following foods because it gives them *natural*, yellow color and vitamin A potency:

Margarine	Shortening
Butter	Cheese
Yellow bakery products	Confections
Edible Oils	

Detailed information about the application of beta carotene 'Roche' is available in a technical brochure. Ask your Roche salesman or write the Vitamin Division for this publication and for samples.

TECHNICAL INFORMATION

Crystalline beta carotene 'Roche' is in the all trans form

Empirical Formula: $C_{40}H_{56}$
Molecular Weight: 536.85
Melting Point: 183.0
Appearance: Red-violet platelets

Solubility in Edible Oils:

At room temperature	about 0.08%
At 60 C.	about 0.2 %
At 100 C.	about 0.8 %

Biological Properties

0.6 microgram beta carotene: 1.0 units of vitamin A
1.0 gram beta carotene: 1,666,666 + U.S.P. units of vitamin A

PACKAGING

33-pound steel pails, double Synthetasine lined, with removable-replaceable-leverlok cover.

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24% Semi-solid Suspension of Beta Carotene 'Roche'
400,000 U.S.P. units per gram 'Roche' beta carotene in vegetable oils.

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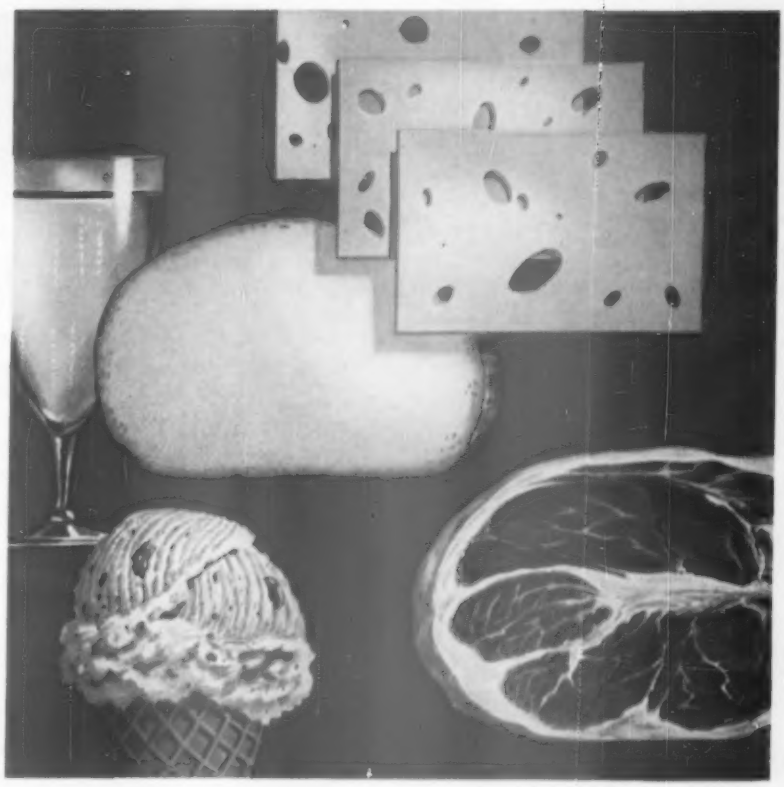

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Affairs of the Institute

Report of the 1955 Council Meeting
Regional Section News
Wm. V. Cruess Award
Phi Tau Sigma Holds First National Meeting
Horticulturists Meet at Michigan State University
Books
Selected Abstracts
Masters and Doctors in Food Technology
Recently Elected Members
Personnel
Future Meetings
Food Industry Topics

Report on the 1955 Meeting of the Council of the Institute of Food Technologists

The Council met in Columbus, Ohio, on June 12, 1955. The following were present:

P. K. Bates, President
L. E. Clifcorn, Pres.-Elect
A. G. Olsen, Treasurer
A. N. Prater, Asst. Treas.
C. O. Ball, At-Large
F. W. Fabian, At-Large
B. S. Clark, At-Large
J. A. Dunn, At-Large
L. A. Hall, At-Large
H. S. Olcott, At-Large
G. E. Brissey, Chicago
J. M. Jackson, Chicago
R. H. Maher, Chicago
S. M. Osri, Chicago (Alt.)
G. T. Peterson, Chicago
E. E. Jacobs, No. Cal.
W. R. Junk, No. Cal. (Alt.)
H. T. Griswold, No. Cal.
E. M. Mrak, No. Cal.
S. A. Goldblith, N. E.
L. B. Sjostrom, N. E.
M. E. Powell, So. Cal.
M. Burns, So. Cal. (Alt.)
S. Carlat, So. Cal. (Alt.)
M. I. Wegner, St. Louis
G. E. Miller, N. Y. (Alt.)
A. A. Schaal, N. Y.
S. L. Galvin, N. Y.
W. S. Conway, Jr., W. N. Y.
L. J. Minor, Gr. Lakes
J. P. Crimmins, Phila.
H. W. Kuhl, Md.
G. M. Danielson, Puget Sound
W. H. Montgomery, Ames
H. D. Brown, Ohio Valley
J. O. Mundt, Dixie
N. W. Desrosier, Ind.
J. F. Caul
R. B. Wakefield
R. E. Morse
W. L. Clark
H. W. von Loesecke
M. S. Peterson, Editor
C. S. Lawrence, Exec. Secy.

1. a) The Council received the report of the Committee on Publications. This report recommended that the Committee on Publications be made a permanent continuing committee, one-half of the members to be replaced each year. The Council adopted this recommendation.

b) The Committee also recommended increasing the non-member foreign subscription rate for Food Technology from $10 to $12. This recommendation was adopted.

c) The Committee recommended that the Institute continue the present policy of allowing a subscription to Food Technology only as a part of the membership dues, and that the present prevailing subscription rate of $7.50 to members for Food Research be continued. The Council adopted these recommendations.

d) The Editor had raised the question of the desirability of publishing a series of monographs. The Council referred this matter to the Committee on Publications and the Ad Hoc Committee on Program Policy for study and recommendation.

e) It has been the practice since the establishment of Food Technology as a monthly journal to require authors to defray a part of the cost of printing papers, that due to special tables, charts or photographs, or where a paper is excessively long, the production cost would be above normal. The Committee on Publications recommended that this policy be officially stated by the Council and incorporated in the By-Laws of the Institute. The Council adopted this recommendation and directed the Editor to prepare a policy statement on this to be included in the By-Laws, to be published in Food Technology and made a part of the next edition of "Suggestions To Authors."

f) The Publications Committee submitted a recommendation of the scope and duties of the Committee on Publications and suggested that these be made a part of the Institute By-Laws. The Council adopted this recommendation.

g) The Council also expressed their thanks to Mr. Wakefield and his Publications Committee for their excellent work during the past year and for a very complete report.

2. a) The Committee on Awards submitted a proposed organization plan for an Awards Committee to include sub-committees for the various awards. The Council adopted this recommendation for a period of one year.

b) The Council instructed the Awards Committee to formulate a procedure for integrating the Nicholas Appert Award into the National Awards Program, due consideration being given to maintaining the prestige of this Award as the oldest and highest honor that can be bestowed by the Institute of Food Technologists; the Committee was directed to discuss and resolve with the Chicago Section the necessary details for accomplishing the integration.

c) The Council instructed the Awards Committee to give due consideration to integrating the Samuel Cate Prescott Award of the Northeast Section into the National Awards Program, due consideration to be given to increasing the prestige of this Award in a manner commensurate with its importance. The Committee was directed to discuss and formulate with the Northeast Section details for accomplishing the integration.

d) The Council, by mail vote May 29, 1955, had accepted a $6,000 per year Post-Doctorate Fellowship sponsored by the Gerber Foods Fund. The Awards Committee submitted to the Council a set of rules for the administration of the Gerber Baby Foods Post-Doctorate Fellowship. These rules, with certain modifications, were adopted by the Council.

e) The donor of the Florasynth Award requested that the rules and regulations governing this Award be amended to make the Award available only to citizens of the United States and Canada. The Council amended the rules and regulations of the Florasynth Award to include the provision requested.

f) A proposal for an award to be sponsored by the Australia Northern and Australia Southern Regional Sections of the Institute, was received. This award was to be in the form of a practical gift such as a set of engraved sterling silver drinking vessels to be awarded

(Continued on page 6)

PRIZE-WINNING BUTTERMAKERS PREFER DIAMOND CRYSTAL FLAKE BUTTER SALT!

MEMO
FROM WILLIAM FOSTER

Jim --

It looks like these Diamond Crystal people make a salt with just the right purity and grain size for every purpose.

Don't you think it would be a good idea to find out how Alberger Salt can help improve our operation?

Bill

Mr. Donald Hedding, of the Hillsboro Cooperative Creamery Co., Hillsboro, Wis., First Prize Winner for Sweet Cream Butter in the 1954 National Butter Scorings at the National Dairy Cattle Congress, Waterloo, Iowa. His butter won the same award in 1950. In both 1949 and 1950, Donald Hedding's sweet cream butter won First Prize in all classes at the Wis. State Fair.

...rystal Flake Butter Salt for over 10 years," says prize winner Donald Hedding, "because Diamond Crystal's 'soft flakes' consistently do the best job in buttermaking of any salt I've ever seen! I'm sold on the way it dissolves quickly and completely in butter . . . leaves no grittiness. Diamond Crystal Flake Butter Salt never requires extra-long working which can produce mottled, sticky butter. It has a pure salt flavor that never imparts a strong, brackish flavor to butter. I've seen what it can do," says champion Donald Hedding, "and that's why it's my choice!"

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- It's the only Butter Salt made by the exclusive Alberger Process of refining which produces unique, quick-dissolving flake crystals!
- It's pure—highest uniform purity assures true salt flavor!
- It's uniformly sized—precision screening produces flakes that are just the right size and solubility for good buttermaking!
- It's clean—the lowest insoluble content of any butter salt!
- It's low in heavy metals—less than 1.5 parts per million of pro-oxidants copper or iron!

DIAMOND CRYSTAL FLAKE BUTTER SALT

America's Largest-Selling High-Grade Butter Salt!

For further information, write to: Dairy Dept., Diamond Crystal Salt Co., St. Clair, Michigan

REPORT OF THE 1955 COUNCIL MEETING

(Continued from page 4)

to an IFT member who has made outstanding efforts to promote the exchange of ideas in the field of Food Technology or whose work has led to such an exchange of ideas or international understanding.

The Council accepted with thanks the generous offer of the Australia Sections and directed the Chairman of the Awards Committee to work out with the donors the rules and regulations to govern this award and submit same to the Council for approval.

3. a) The Council received the report of the Treasurer. This report showed total receipts of $145,703.73 and total expenditures of $132,465.58. The report further showed that the Institute began the Fiscal Year '54-'55 with $47,329.25 in Cash and ended the year with $60,567.40. In addition to the Cash Account, the report shows that the Institute owns $39,878.86 in U. S. Treasury 90-Day Notes and one $914.00 U. S. Savings Bond.

b) The Treasurer presented to the Council the following Budget prepared by the Finance Committee and amended by the Executive Committee:

1955-1956 Budget

RECEIPTS:	
Membership Dues	$ 30,197.00
Non-Member Subs. FT	7,424.00
Member Subscriptions FR	4,717.00
Non-Member Subs. FR	11,390.00
Advertising Inc. FT (less Agency Comm.)	63,800.00
Advertising Inc. FR (less Agency Comm.)	512.00
Income from Annual Meetings (Net) (1955)	7,000.00
Sale of Back Issues (FT, FR and Dir.)	600.00
Interest Earned	300.00
Misc. Receipts	350.00
	$126,290.00
EXPENDITURES:	
FT Printing and Mailing	$ 50,172.00
FT Circulation Expense	1,000.00
FT Adv. Sales and Handling Expense	15,500.00
FR Printing and Mailing	11,683.00
FR Circulation Expense	1,250.00
FR Adv. Handling Expense	30.00
Editorial Expense:	
Salaries	8,000.00
Maintenance	1,000.00
Travel	700.00
Contingencies	500.00
Rent, Telephone and Telegraph	3,000.00
Stationery, Printing and Postage	3,500.00
Clerical and Accounting Expense	8,700.00
Taxes	750.00
Secretary's Salary	9,900.00
President's Office	600.00
Office Furniture and Equipment	600.00
General Expense—National Headquarters	1,200.00
Travel	1,500.00
Contingencies (Pres. Fund)	500.00
Audits, Bonds and Insurance	1,000.00
News Program	750.00
Directory—1955-1956 (Net)	1,200.00
	$123,035.00

The Council adopted the foregoing Budget.

4. a) The Council received the report of the Executive Secretary. His report showed total paid members as of April 30, 1955 was 4,157. This is a net gain of 221 members during the year. Actually, 543 new members were elected but there were 90 deaths and resignations and 232 dropped for non-payment of dues. FOOD TECHNOLOGY as of April 30th had a net paid circulation of 5,085. This was a net gain of 407 in circulation during the year. FOOD RESEARCH showed a total net paid circulation of 1,969, a gain of 26 for the year. This Journal financially is now on a break-even basis.

The journal production records show that during the Fiscal Year 63,844 copies of FOOD TECHNOLOGY were printed at a cost of $45,520.02. The twelve issues contained 1,116 pages. FOOD RESEARCH, 13,534 copies produced at a cost of $10,454.12. The six issues contained 612 pages.

b) The Secretary presented a request from one of the Regional Sections for reimbursement of expenses incurred by one of the sub-committees of an Institute technical committee. The Council declined to take any action in this matter but referred it to the new administration under Dr. Clifcorn.

c) The Council adopted the following policy—"No individual, Institute Committee or employee of the Institute shall incur any indebtedness in the name of the Institute or make any commitments involving the Institute unless specifically authorized to do so by Council action." The Council also directed that when an Institute Committee is appointed, the Chairman of the Committee must be informed of the provisions of the foregoing resolution.

d) The Secretary pointed out the need for an official emblem of the Institute and recommended that a professional heraldic expert be commissioned to submit to the Executive Committee a number of design sketches in order that this Committee may make a final selection. The Council authorized funds of not more than $150 for this purpose.

e) The question was raised as to whether or not the Institute had previously adopted an official emblem. There was some difference of opinion on this subject. The Council by formal resolution directed that, "If the Council had ever adopted an official emblem, such action is hereby rescinded."

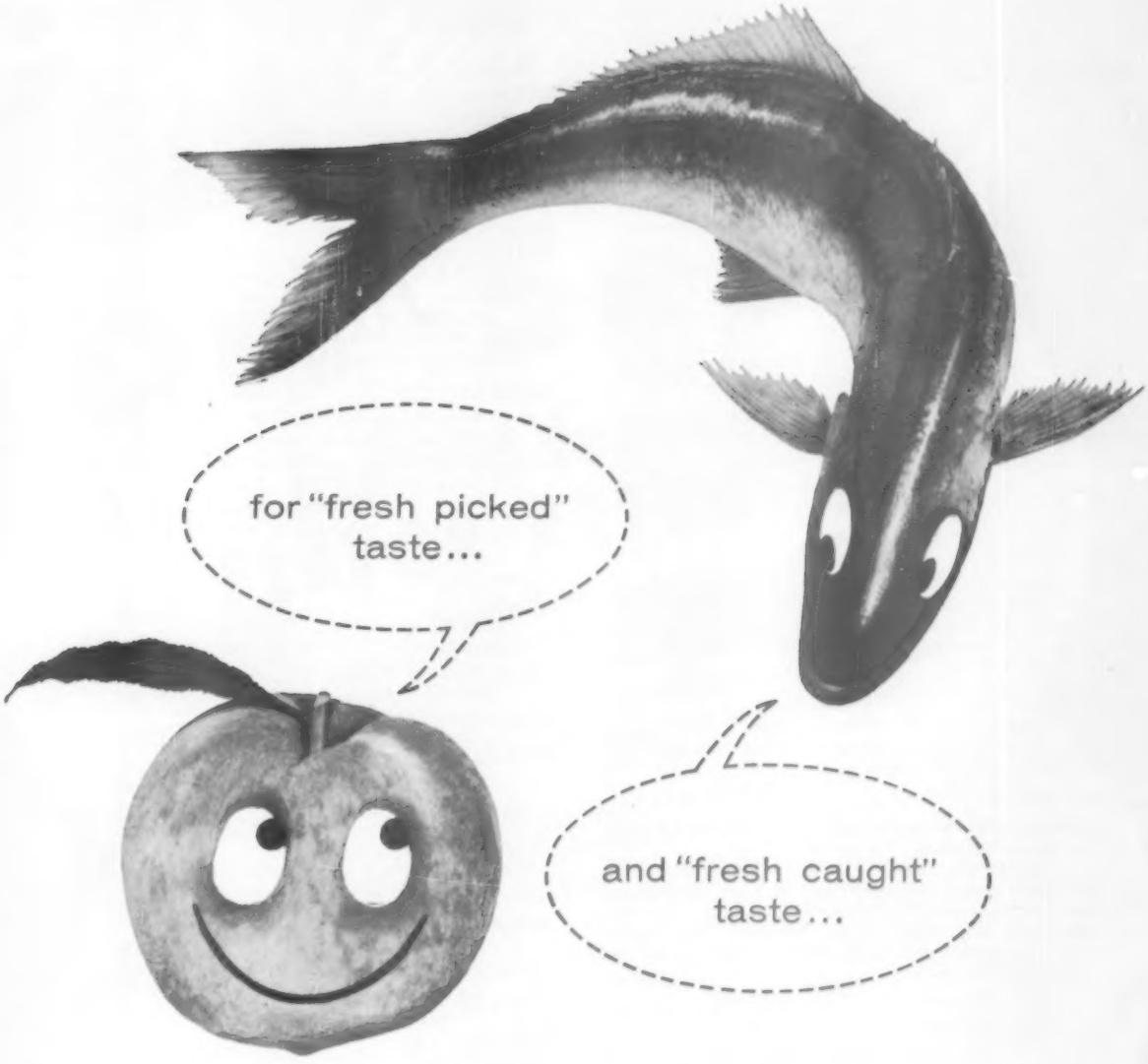
f) The matter of furnishing Institute Membership Certificates to all members was discussed. Such certificates are presently available at cost—hand written, 50¢ each; engrossed, $2.50 each. The Council directed that the next administration study this matter, and determine if a sufficient number of members desire certificates, to warrant furnishing a free certificate to all members.

g) The following paragraphs covering the financial status of the Institute were taken verbatim from the audit report rendered by George V. Rountree & Company, Certified Public Accountants:

Auditor's Report

Following is a summary of the financial condition of the Institute at April 30, 1955 and April 30, 1954:

(Continued on page 8)



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REPORT OF THE 1955 COUNCIL MEETING

(Continued from page 6)

Particulars	April 30, 1955	1954	Increase Decrease*
ASSETS			
Cash	$ 60,567.40	$47,329.25	$13,238.15
U. S. Treasury notes	39,878.86	19,948.00	19,930.86
Accounts receivable	4,555.39	3,999.86	555.53
Investment	914.00	887.00	27.00
Inventories		156.15	156.15*
Prepaid insurance	36.00	217.05	181.05*
Furniture and fixtures (net)	565.47	601.84	36.37*
Total	$106,517.12	$73,139.15	$33,377.97
LIABILITIES			
Prepaid exhibit fees	$ 16,950.07		$16,950.07
Deferred income	12,852.00	$ 9,144.00	3,708.00
Capital	76,715.05	63,995.15	12,719.90
Total	$106,517.12	$73,139.15	$33,377.97

Balance Sheet

Cash:

General fund $51,988.11; operating fund $8,579.29.

Bank balances are in agreement with a certificate furnished us by The First National Bank of Chicago after taking into consideration checks not presented for payment April 30, 1955.

U. S. Treasury 90-day notes $39,878.86.

The Institute owns $40,000.00 face value U. S. Treasury notes which are being held by The First National Bank of Chicago for safekeeping.

Accounts receivable:

The Garrard Press $2,055.39; Ohio Valley Regional Section of the Institute $2,500.00.

The balance due from The Garrard Press represents principally charges for advertising in Food Technology and Food Research which the publisher collects from the advertisers and remits to the Institute. The balance which was confirmed directly with the publisher may be summarized as follows:

Food Technology	$1,559.74
Food Research	495.65
Total	$2,055.39

An advance of $2,500.00 has been made to the Ohio Valley Regional Section of the Institute to be used for payment of expenses incurred in connection with the Annual Meeting to be held at the Deshler-Hilton Hotel, Columbus, Ohio, during the period June 12 to 16, 1955.

Unexpired insurance $36.00.

In addition to a blanket position bond of $50,000.00, the Institute carries workmen's compensation and general liability insurance.

Investment:

U. S. Savings Bond, Series "F" $914.00.

The Series "F" bond, having a face value of $1,000.00 and a redemption value at April 30, 1955 of $914.00 was presented for our examination.

Furniture and fixtures $565.47.

Additions to furniture and fixtures totaled $559.61 and are summarized below:

Varifax copier	$240.00
Used Sundstrand adding machine	193.80
File cabinet	66.30
Drapes	30.75
6 storage file cases	28.76
Total	$559.61

Depreciation was computed for the year at the rate of 20% per annum amounting to $595.98.

Prepaid exhibit fees $16,950.07.

Fees collected for exhibit space at the Annual Meeting to be held in Columbus, Ohio, have been deferred to 1955-56 operations.

Deferred income $12,852.00.

Non-member subscriptions to Food Technology and Food Research are billed on a calendar year basis. Since the Institute is required to furnish journals to subscribers for the remainder of the year, subscriptions for the eight months ending December 31, 1955 amounting to $12,852.00 have been deferred.

Capital $76, 715.05.

The capital at May 1, 1954 amounted to $63,995.15 to which was added the current net income of $12,719.90, making a balance at close of the year of $76,715.05.

Balance Sheet
April 30, 1955

ASSETS

Current Assets			
Cash:			
General fund	$51,988.11		
Operating fund	8,579.29	$60,567.40	
U. S. Treasury 90-day notes at cost		39,878.86	
Accounts receivable:			
The Garrard Press	2,055.39		
Ohio Valley Regional Section of the Institute	2,500.00	4,555.39	
Unexpired insurance		36.00	$105,037.65
Investment			
U. S. Savings Bond Series F due August 1957 at redemption value			914.00
Furniture and Fixtures			
At cost		2,979.88	
Less: Accumulated depreciation		2,414.41	565.47
Total			$106,517.12

LIABILITIES

Current Liabilities			
Prepaid exhibit fees			$ 16,950.07
Deferred Income			
Non-member subscriptions to journals			12,852.00
Capital			
Balance May 1, 1954		$63,995.15	
Add: Net income year ended April 30, 1955		12,719.90	76,715.05
Total			$106,517.12

5. The Editor presented to the Council a very thorough review of his annual report. This report contained recommendations for the number of pages to be allotted to Food Technology and Food Research for the current fiscal year.

The Editor's recommendations were included in the Budget—1,230 pages for Food Technology and 684 pages for Food Research.

6. The Council granted a charter to a group of Food Technologists in the Omaha, Nebraska area, chartering this group as the AK-SAR-BEN Regional Section of the Institute.

(Continued on page 10)

Presenting . . .

Dri-Seal

The Latest Advancement in FLAVOR RETENTION

Shelf Life of your finished products will be materially lengthened through the use of N. B. W. DRI-SEAL, the dry food flavor which remains fresh indefinitely.

DRI-SEAL is a process whereby millions of atomized flavor globules are hermetically sealed within a shell of edible gum.

No evaporation, oxidation, deterioration through contact with air, or cross blending with other product ingredients can occur as long as the product remains reasonably moisture free.

Since the protective coating of DRI-SEAL is instantly soluble in water, the flavor is released by the consumer in its original strength at the time the product is used.

SAMPLES AND TECHNICAL DATA ON REQUEST

Especially Recommended for:

Cake Mixes • Decorating Sugars • Desserts Powders • Gelatin Desserts • Icing Mixes • Ice Cream Mixes • Pastry Fillings • Soft Drink Powders • Pharmaceuticals

Manufactured by

NEUMANN-BUSLEE & WOLFE, INC.

5800 NORTHWEST HIGHWAY CHICAGO 31, ILL.

REPORT OF THE 1955 COUNCIL MEETING

(Continued from page 8)

7. The Council accepted the invitation of the Northern California Section to be hosts at the Annual Meeting of the Institute in San Francisco in 1960.

8. The Council received the report of the Committee on Constitution and By-Laws recommending certain changes in Article VII, Section 3 and Article VIII, Section 1 of the Constitution. These recommendations were approved by the Council and since that time have been submitted to the Institute membership for vote by mail.

9. The Council reappointed the following officers of the Institute for a period of one year: Aksel G. Olsen, Treasurer; Arthur N. Prater, Assistant Treasurer; Martin S. Peterson, Editor; Charles S. Lawrence, Executive Secretary and Marian A. Gilchrist, Assistant Executive Secretary.

10. The reports of the remaining Institute Committees were accepted.

11. The Council directed that the present regulations governing Annual Meetings be amended to require that the cost of luncheons for the Executive Committee and the Council be paid by the Institute rather than by the Host Section and that these expenses be charged to the Annual Meeting account.

12. The Council directed the President to delegate to a suitable committee the task of making a study of the Institute's present policy regarding the publication and issue of a Directory bearing in mind that it is the desire of the Council to adopt a policy that will make the Directory of greatest value to Institute members. The Council also granted to the Executive Committee the power to take such action as that committee may deem necessary in this matter.

13. The Council extended its thanks and appreciation to the Officers of the Institute, the Editor, and the Editorial Boards, for the excellent manner in which they have conducted their activities during the past year.

14. An informal invitation was extended by the New York Section to be hosts at either the 1961, 1962 or 1963 Annual Meetings. A formal invitation will be presented at a later date.

15. Several Councilors expressed the opinion that since a substantial income is derived from Exhibits, considerable thought should be given to providing adequate facilities wherever Annual Meetings are to be held. The Executive Secretary stated that the Institute has the counsel and advice of an Industry Exhibitors Committee composed of representatives of a number of firms who participate regularly in our Exhibits. This Committee holds one or more meetings each year and submits their recommendations to the Executive Secretary. The Secretary stated that this has been most helpful and as time goes on will make the Exhibits more valuable to the Exhibitor and a source of increasing income to the Institute.

16. The Council extended its thanks and appreciation to the Ohio Valley Section for acting as Hosts at this Annual Meeting.

Regional Section News

OREGON SECTION

The Oregon Section of the IFT held the annual election May 6, 1955, at Astoria, Oregon, with the following results:

Chairman: Edward W. Harvey, Associate Food Technologist, Food Technology Dept., Oregon State College, in charge; Seafoods Laboratory, Astoria, Oregon.

Vice Chairman: Alton C. McCully, Research Director, Eugene Fruit Growers Association, Eugene, Oregon.

Secretary-Treasurer: Curtis J. Wilder, Assistant Food Technologist, Food Technology Dept., Oregon State College, Corvallis, Oregon.

Councillor: Charles L. Beardsley, Food Technologist, Apple Growers Association, Hood River, Oregon.

Executive Committee: George P. Henken, Assistant Maintenance Superintendent, Blue Lake Packers, Salem, Oregon; Arthur W. Anderson, Assistant Professor of Bacteriology, Bacteriology Dept., Oregon State College, Corvallis, Oregon.

TEXAS SECTION

Texas Section held a meeting at 2:00 p.m. June 30, 1955 aboard the yacht *Sam Houston*. The group enjoyed a tour down the Houston Ship Channel to the San Jacinto Battleground during which time a short business session was held.

On returning from the boat trip, the group drove to the Grand Prize Brewery where a tour was made of the plant. Following the tour the group enjoyed a barbecue dinner. After dinner two interesting papers on the subject of yeast were presented by Mr. Miller, Chief Chemist for Grand Prize and by Mr. Horn, also of Grand Prize. A colorful movie of a trip made by Mr. Lieberman of this company to some of the breweries in Europe during the past autumn was the final feature of the evening.

MARYLAND SECTION

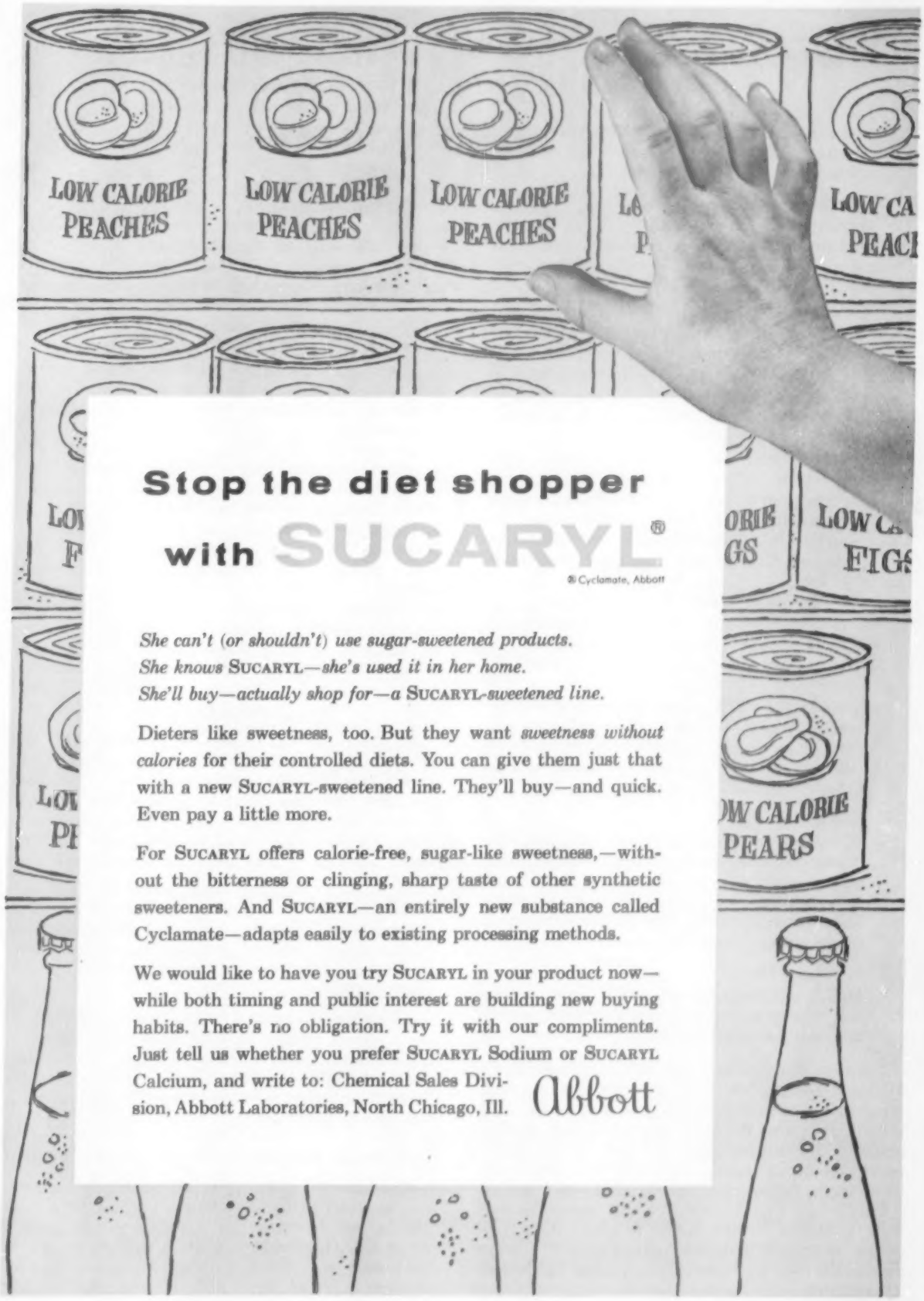
Thirty-five members and guests were present at the Maryland Section's May 6th dinner meeting which was held at the Stafford Hotel in Baltimore, Maryland. Mr. Virgil S. Troy, Chief of the Microbiology Section of the Continental Can Company, Inc. at Chicago, Illinois, addressed the group on "Some Microbiological Problems in the Food Processing Industry."

While it must be emphasized that, statistically, spoilage of modern canned foods is very insignificant, nevertheless it has been known to occur and the Food Technologist must be familiar with it in order to prevent it. On this theme, Mr. Troy treated:

A. Incipient spoilage which occurs prior to processing.

Spoilage of this type can be due to delivery of over-ripe or otherwise spoiled food products from the farm to the processor, or to spoilage which develops in the product while awaiting processing at the plant.

(Continued on page 12)



Stop the diet shopper with SUCARYL®

® Cyclamate, Abbott

She can't (or shouldn't) use sugar-sweetened products.
She knows SUCARYL—*she's used it in her home.*
She'll buy—actually shop for—a SUCARYL*-sweetened line.*

Dieters like sweetness, too. But they want *sweetness without calories* for their controlled diets. You can give them just that with a new SUCARYL-sweetened line. They'll buy—and quick. Even pay a little more.

For SUCARYL offers calorie-free, sugar-like sweetness,—without the bitterness or clinging, sharp taste of other synthetic sweeteners. And SUCARYL—an entirely new substance called Cyclamate—adapts easily to existing processing methods.

We would like to have you try SUCARYL in your product now—while both timing and public interest are building new buying habits. There's no obligation. Try it with our compliments. Just tell us whether you prefer SUCARYL Sodium or SUCARYL Calcium, and write to: Chemical Sales Division, Abbott Laboratories, North Chicago, Ill.

Abbott

REGIONAL SECTION NEWS

(Continued from page 10)

The processor can substantially reduce this by proper supervision of his suppliers, their transportation system and his own scheduling and storage facilities.

B. Under-processing.

When the processing temperature is too low, the time too short or the temperature distribution uneven, spoilage chances run high. Technologists class the spoilage as follows:

1. *Putrifactive*—Evidenced by strong odor and caused by processes not approved by the National Canners Association.
2. *Flat sour*—No "Swell Heads," thus hard to detect except by evidence of sour taste, or lower-than-normal pH. Caused by facultative aerobes or anaerobes on foods.
3. *Thermophilic gaseous*—"Swell Heads" show up easily. Caused by thermophiiic spores present on improperly cleaned foods which resist normal sterilization temperatures. To prevent this type of spoilage, cool well before stacking in storeroom, after thorough cleaning of food.
4. *Sulfide*—Easily noticed if each batch is sampled, since samples show up blackened. The cause is—by-passing of the retort or poor head space allowing surplus air, with consequent subnormal temperature.
5. *Gross under-processing*—A combination of results show up in this case, dependent on pH, temperature, air, time and temperature distribution. This can lead to deadly botulinum contamination, which is not detected by taste.

C. Leakage

When cans are improperly sealed and air, contaminated cooling water or other foreign matter gains entrance, the product will spoil. Thus a continuous check must be made on the sealer. Chlorination of cooling water is also very helpful, in case seepage should take place.

D. Hydrogen Swells

Highly acid foods that attack the metal container will develop hydrogen pressure sufficient to swell and later perforate the can.

Tomatoes being of high economic importance to the Maryland Section, Mr. Troy discussed them specially. He described cases of flat sour, spoilage of tomato juice and also compared the flavor benefits of flash sterilization with conventional heat treatment. When whole tomatoes are water-cooled, after retorting, there is less thermophylic flat sour trouble, according to his findings.

Finally Mr. Troy advised that after processing, care must be used to prevent damage to cans. All things—proper sanitation, accepted processing and constant supervision—are a guarantee of a perfect high-quality product.

NORTHERN CALIFORNIA SECTION

The *IFT Hornblower*, this Section's official mouthpiece, carried an impressive front cover on its May-June issue. The cover featured an artist's portrait of Dr. William V. Cruess. As a matter of fact, the Section's June 2nd meeting, held in the Terrace Room of the Fairmont Hotel in San Francisco, was known as the "Bill" Cruess Meeting, highlight of which was the presentation of the Prescott Award, presentations to Professor Cruess and the unveiling of a portrait of Professor Cruess by Mrs. Cruess. Donations for a personal gift were received both from America and abroad and the monies pooled so that "Bill" could purchase something he especially wanted. From the "Commodore's Column" in *The Hornblower*, we quote:

"The entire Staff of the *Hornblower*, and I think there is no doubt that we speak for the entire Northern California Section of The Institute of Food Technologists, wish to go on record in this issue of the *Hornblower*, to wish, pray and in general conjure up all that is good, and nothing that is bad for our good friend and professor, William V. Cruess. We have always known that when we were in a jam, we could take it to 'Bill' and he would make our problem his problem. Thank you, 'Bill', for your encouragement along our lives' pathway, and as you sit and gaze into the fire at eventide, just remember that practically every development in Food Technology has some of 'Bill' Cruess in it. Again we all thank you, and as Commodore I exercise my authority to herewith and for all time to come, appoint you 'Honorary Commodore *Hornblower*.'"

PERSONNEL

Dr. Ernest E. Lockhart, nutritional authority and former physiologist for an Antarctic expedition sponsored by the U. S. Department of the Interior, has been appointed Scientific Director of the Coffee Brewing Institute, Inc., according to an announcement by Andres Uribe, president. He will assume direction of all research activities for the Institute in September.

Dr. Lockhart, member of the faculty of the Massachusetts Institute of Technology for the past ten years, has long been active and prominent in the fields of food chemistry, nutritional biochemistry, enzyme chemistry, flavor evaluation, food acceptance and radiation preservation of foods.

Professor W. J. Stadelman, Department of Poultry Sciences, State College of Washington, Pullman, has accepted a position on the faculty at Purdue University, Lafayette, Indiana, where he will continue his research on poultry products. He will be located in his new post in September.

FOR FOOD TECHNOLOGISTS HAWAII-BOUND

Hawaiian food technologists are looking for speakers. Any members of the Institute who are planning to visit Hawaii and who would be interested in talking on a phase of food technology in which they are specialized are invited to write to Dr. George E. Felton, Hawaiian Pineapple Co. Ltd., P. O. 3380, Honolulu 1, Hawaii.

FLAVORS for that VERY SPECIAL EFFECT...

Do you take real pride in the quality and flavor of your food products? If so, you'll want to know more about the following flavoring specialties, each of which has been developed to impart certain very special effects and to lend extra taste appeal to the finished goods.

CHEERIO...

For the makers of fruit cakes, plum puddings, and mince meats! These traditional holiday specialties may be greatly enriched in flavor and aroma by the economical use of the following remarkably successful flavoring specialties:

OIL BRANDY IMITATION No. 08

OIL RUM JAMAICA IMITATION No. 017

OIL MINCE MEAT SPICE

Samples and particulars on request.

REALLY TOPS...

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PURE VANILLA CONCENTRATE TENFOLD BOURBON

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EKOMO VANILLA IMITATION

FLAVOR COMPOUND No. 23274

BUTTER VANILLA IMITATION

Write for samples and recommended applications.

NUTTY, BUT NICE...

Nutmeats are a sure-fire consumer favorite—as the makers of cakes, candies and pudding desserts very well know. Their use of these popular ingredients is sometimes restricted, however, by the high cost of nutmeats and availability of supplies. To help lower costs and stretch limited supplies, many manufacturers are using our Imitation Nut Flavors in their formulations to very excellent advantage. Write us for samples and suggestions for using any of the following:

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Why we bother with molecular distillation

Molecular distillation under high vacuum is a lot of trouble we wouldn't go to if we knew of a better way to do what we're doing.

It happens to be the most economical and practical way to take a reaction mixture of glycerine and a fat and strip off only the molecules with one fatty acid chain. And it works fine. We produce monoglyceride emulsifiers of unusually high monoester content by the tank car; monoglycerides free of soaps, catalysts, and free fatty acids; creamy white monoglycerides as wholesome as any food we know of. We call them Myverol Distilled Monoglycerides.

Now Myverols cost more to buy than the usual mono-diglyceride mixtures. They have to. But they cost less to use because they go so much farther in emulsifying effectiveness per pound.

Take shortening for household use, for example. One percent Myverol Distilled Monoglycerides does a real job. What other monoglyceride preparation will do much at a level as low as that? And, because they're so pure, you can add Myverols after deodorization without affecting the color, odor, or flavor of the finished product.

We make Myverol Distilled Monoglycerides in a number of types from a number of fats and oils. The best way to evaluate them is to try some in your own product. We'll send you samples without charge. If you'll let us know what you want them for, we'll recommend the type. ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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distillers of monoglycerides made from natural fats and oils

DPi

Also . . . vitamin A in bulk for foods and pharmaceuticals

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William V. Cruess Award Won by McDonald P. Benjamin, University of California, Davis

McDonald P. Benjamin, Jamaican student on the University of California campus at Davis, has been awarded a scholarship by the Institute of Food Technologists, national scientific organization of food researchers.

Benjamin, a food technology major, was given the William V. Cruess award for his outstanding scholarship. It is a new award, set up and administered by the Northern California Section of IFT, honoring Dr. W. V. Cruess, distinguished professor of food technology, emeritus, on the Berkeley campus.

Benjamin's home is at Montega Bay, Jamaica.

Phi Tau Sigma Holds First National Meeting

The first National meeting of Phi Tau Sigma, the honor society for food science, was held on June 15th in conjunction with the Institute of Food Technologists convention in Columbus, Ohio.

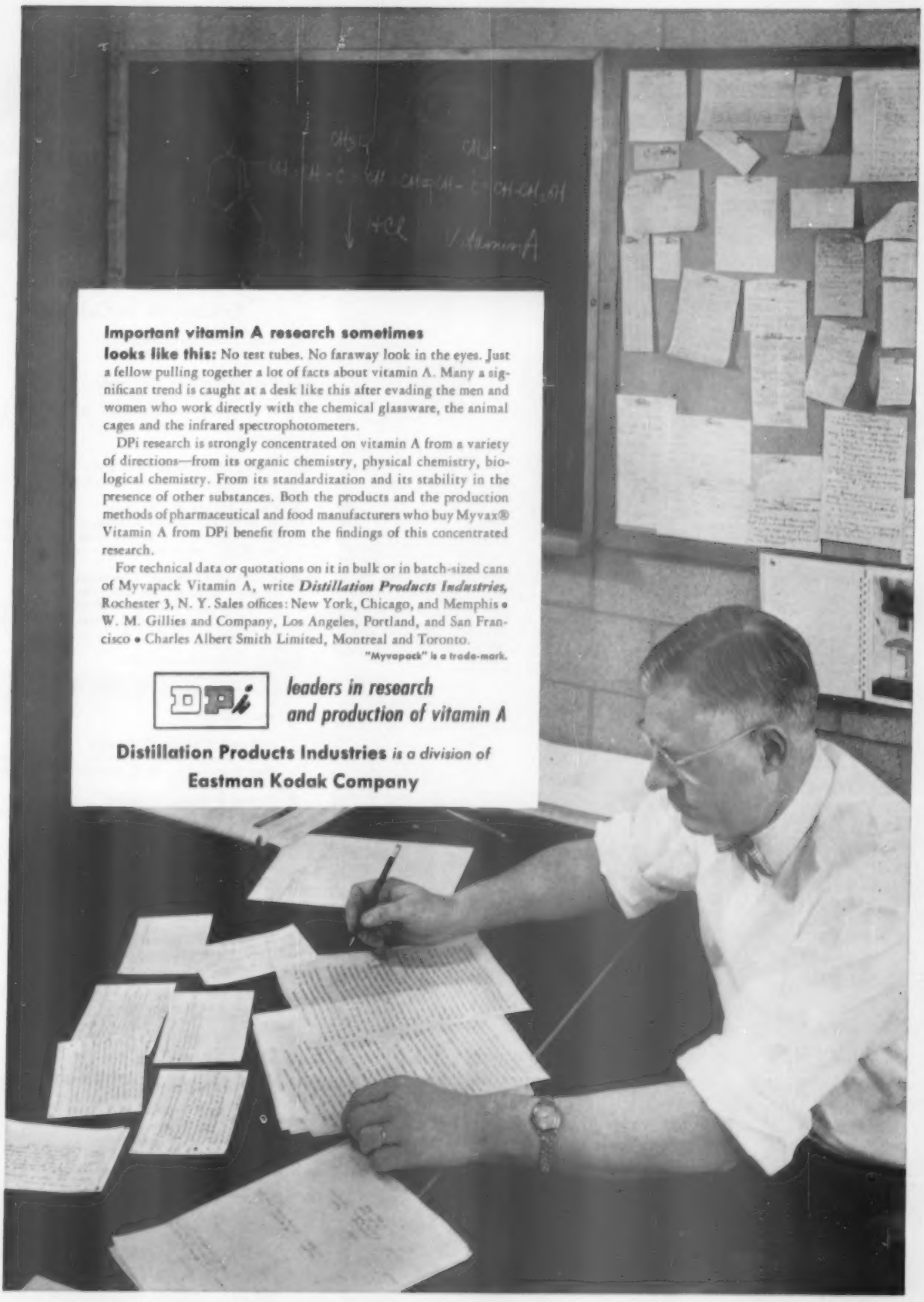
Highlight of the meeting was the presentation to chapter delegates of their respective chapters' charters. All members present were also awarded their individual membership certificates.

In a meeting of Phi Tau Sigma's National Council, preceding the general meeting, Dr. F. John Francis, assistant research professor of Food Technology at the University of Massachusetts, was appointed Executive Secretary of the Society, replacing Mr. Enio Feliciotti who recently resigned.

Coinciding with the national meeting was the publication of the first issue of the society's journal: *The Food Scientist.* Appointed to the Publications Committee, with jurisdiction over *The Food Scientist,* were Dr. C. Olin Ball, former editor of FOOD TECHNOLOGY, and Dr. Lawrence V. Burton, formerly editor of *Food Industries.*

PRESENTATION OF PHI TAU SIGMA CHAPTER CHARTERS

Receiving charters of their respective chapters from Prof. G. E. Livingston, Phi Tau Sigma president, are Dean S. C. Prescott of M. I. T., Prof. C. R. Fellers of the University of Massachusetts, and Prof. W. A. MacInn of Rutgers University. Standing at left is Prof. F. J. Francis, executive secretary.



Important vitamin A research sometimes looks like this: No test tubes. No faraway look in the eyes. Just a fellow pulling together a lot of facts about vitamin A. Many a significant trend is caught at a desk like this after evading the men and women who work directly with the chemical glassware, the animal cages and the infrared spectrophotometers.

DPi research is strongly concentrated on vitamin A from a variety of directions—from its organic chemistry, physical chemistry, biological chemistry. From its standardization and its stability in the presence of other substances. Both the products and the production methods of pharmaceutical and food manufacturers who buy Myvax® Vitamin A from DPi benefit from the findings of this concentrated research.

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DPi *leaders in research and production of vitamin A*

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   Al Fonyo, V. P., Seb Davin
2. **Walker-Wallace Division, A. P. V. Company, Inc.**
   G. M. Irving, Walker-Wallace; Mrs. C. W. DuBois and Children of Orlando, Fla., L. J. Bruens, Walker-Wallace.
3. **David Michael & Co., Inc.**
   Wm. B. Rosskam, Harold Prutt and Raymond J. Vashro.
4. **Chas. Pfizer & Co., Inc.**
   E. W. Marlier, James F. Irwin and E. E. MacDonough, Chas. Pfizer & Co., Werner Stock, Viaking Corp., C. L. Wrenshall, Chas. Pfizer & Co.
5. **Seaplant Chemical Corporation**
   Thomas Chapman, Seaplant Chemical, Mrs. Florence Glazier, Kroger Co., Melvin Mickevic and George Poindexter, Seaplant Chemical, Oscar Spiegelhalder, Holloway Corp.
6. **Polak & Schwarz, Inc.**
   Frank Micek, Polak & Schwarz; Irv Rapp, Felton Chemical; Louis Davids, Chas. H. Grimm and George M. Bitzick, Polak & Schwarz; Ivan D. Jones, N. C. State College.
7. **General Electric Company**
   C. H. Wantz, General Electric; Frank Lawler, Editor Food Engineering; R. E. Scarbrough, General Electric.
8. **Rohm & Haas Company**
   Gerald Reed, Rohm & Haas; Marcel D. Labbee.
9. **Bausch & Lomb Optical Company**
   Donald H. Carter, James Starks.
10. **Fritzsche Brothers, Inc.**
    Mrs. R. Romerantz, Kraft Foods; C. W. Edwards and R. E. Bull, Fritzsche Brothers.
11. **Wyandotte Chemical Corporation**
    A. W. Hefti, J. L. Danenhouer, W. H. Schutte and F. A. Troxell.

One roll of photographer's film was light struck, therefore, not all exhibitors are shown.

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Stability is a prime quality of MERCK VITAMIN A. Our chemists have established this by many tests, including collaborative work with manufacturer-customers. Many margarines fortified with MERCK VITAMIN A have maintained their full vitamin A potency, even after 5 months of storage at 40° F.

This assured stability of MERCK VITAMIN A helps to ensure product quality. Available as the Palmitate or the Acetate, MERCK VITAMIN A is consistently light-colored, clear and homogeneous, and free from off-tastes and odors. Batch size or bulk containers are offered to meet every need. And Merck Technical Service is always ready to aid you in applying vitamin A to your products.

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Horticulturists to Meet at Michigan State University

Leading horticulturists from all parts of the nation will report results of recent experiments at the annual meetings of the American Society for Horticultural Science at Michigan State University, East Lansing, Michigan, for three days beginning September 6, 1955.

Some of the outstanding papers that processors will want to hear are as follows:

1. THOMAS, F. B.: Electron Irradiation of Blueberries and Peaches.
2. KATTAN, A. A.: Preharvest Factors Affecting Quality of Tomatoes and Tomato Products.
3. MCCONNELL, E. R., J. M. HUFFINGTON AND P. B. GOTSHALLY, JR.: Influence of Variety and Storage on Quality of Canned Louisiana Sweet Potatoes.
4. KENWORTHY, A. L.: Leaf Analysis as a Grower Service in Michigan.
5. BATJER, L. P.: Eleven Years' Results with Chemical Thinning in Central Washington.
6. RALM, E. M.: The Effect of Certain Cultural and Growth Regulator Treatments on Pod-Set and Yield of Lima Beans.
7. WITTWER, S. H., AND F. G. TEUBNER: Influence of Cold Temperature Exposure of Tomato Seedlings on Flower Formation.
8. EMMERT, E. M.: Use of Pigmented Polyethylene for Weed Control and for Forcing and Irrigating Vegetables.

Dr. E. S. Haber, President of the Society, will be guest speaker at a banquet on Wednesday evening, September 7. Dr. Haber is a noted sweet corn breeder and Head of the Department of Horticulture at Iowa State College, Ames, Iowa.

Bus tours of important areas of fruit, vegetable, flower and nursery crop production in Michigan will be available for interested parties on September 9 and 10, immediately following the meetings.

Lodging and meals will be available on the University campus either in residence halls or the Kellogg Center for Continuing Education. To make advanced registrations you may write to J. D. Jackson, Continuing Education Center, Michigan State University, East Lansing, Michigan.

Books

INFORMATION PROCESSING EQUIPMENT. Ed. M. P. Doss. Reinhold Publishing Corp., New York, N. Y.

With the growth of scientific and technological knowledge, has come a parallel growth in paper work. Fortunately, the growth in paper work has been paralleled in turn by the development of faster and better ways to type manuscripts, to provide multiple copies of typescript, to collate sheets of copy, to handle numerical data, and to do the numerous other things required in contemporary technical communication.

Information Processing Equipment covers much of the equipment available today in the information-processing field. Each chapter has been contributed by a specialist in a given operation, and the range of information is therefore both wide and authentic. The first chapter treats modern equipment for typing, stenciling, hectographing, and certain related operations such as collating or gathering the reproduced sheets in proper sequence. Subsequent chapters describe equipment for photography in the laboratory, making slides, microcopying, and for offset and letterpress printing. The chapter on lensless copying with sensitized papers will be of interest to all those who have experienced a need for several copies of an important letter or report, fast. But no questions should be asked as to the beauty of these quick but faithful reproductions. They are for utility purposes only.

Storing and finding information forms one of the concluding chapters, and a good survey of equipment for punched cards is provided therein. The final chapter discusses numerical data-handling machines. Representative devices of three types—manually operated, automatically operated, and automatic data converting—are described. One item that caught this reviewer's eye was a little hand calculator, resembling a fisherman's reel, that will add, subtract, multiply, and divide. It refuses to work on problems that result in answers containing more than 11 digits, however, and if your losses, or payroll, or taxes amount to more than $99,999,999,999 you'll have to go to a larger machine. Incidentally, there are data-handling devices that occupy several rooms. On the horizon is a machine to be known as the Random Access Memory—with a capacity of one million locations and two hundred characters of information at each location. The access time to any one of the million locations will be less than one second. M. S. P.

Selected Abstracts*

ANALYTICAL METHODS

The infrared spectra of mono-, di-, and triglycerides.

O'CONNOR, R. T., DUPRE, E. F., AND FEUGE, R. O. *J. Am. Oil Chemists' Soc., 32,* 88-93 (1955).

The i.r. spectra from 2-12 μ of $CHCl_3$ solns. of several glycerides have been measured and studied with a view to possible analytical applications. These spectra are presented, and conclusions which can be obtained from their examn. are reported in this paper.

Molecular sieving properties of starch.

LINDQVIST, B., AND STORGARDS, T. *Nature, 175,* 511-12 (1955).

The authors conclude that starch acts as a mol. sieve with a sepn. range between the mol. wt. of 75-500. They suggest such mol.-sieving as a potential analytical and isolation method.

Determination of specific surface of sieve-size powders.

DUBROW, B., AND NIERADKA, M. *Anal. Chem., 27,* 302-5 (1955).

This work extends the range of air permeability measurements to sieve-size powders. An instrument which employs a sensitive adjustable flowmeter was developed. The accuracy and precision of the method indicate that the instrument can readily be adapted for rapid routine measurements of specific surface or av. particle size in the range investigated.

BIOLOGICAL SCIENCES

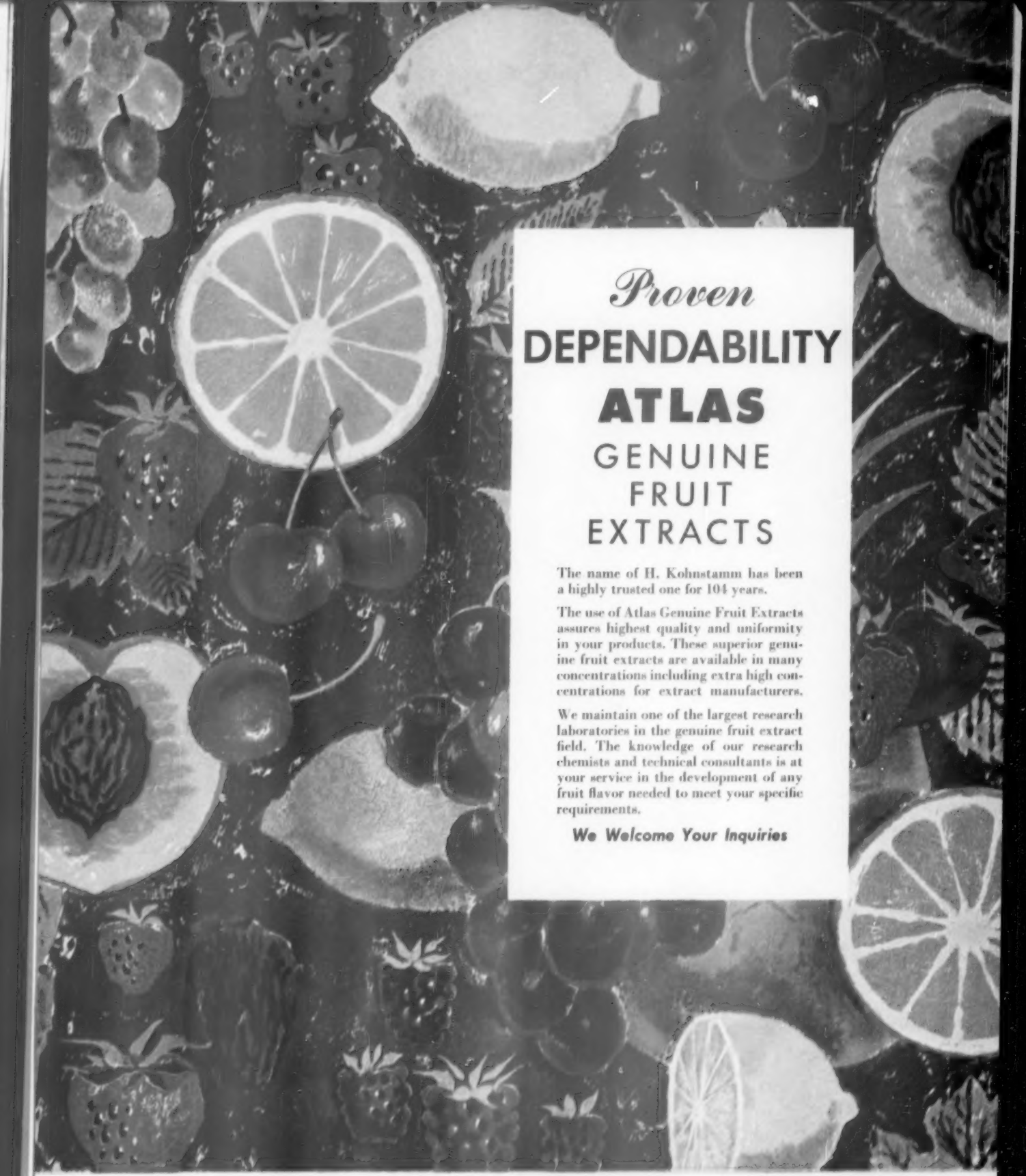
BIOCHEMISTRY

Effects of trace metals, oxygen and light on the glucose-glycine browning reaction.

BOHART, G. S., AND CARSON, J. F. *Nature, 175,* 470-1 (1955).

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Dr. H. A. Campbell and the General Foods Corporation of White Plains, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 20)



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SELECTED ABSTRACTS

(Continued from page 18)

The browning of an aq. glucose-glycine mixt. was found to be affected by the presence of trace amts. of Mn and Fe, O and light. In the presence of O and absence of light, the browning effect was inhibited by Mn and accelerated by Fe. In the absence of light, the exclusion of O accelerated browning, and under these conditions Mn exhibited no inhibitory effect. The presence of light was found to accelerate browning when O was excluded. On partly browned solns., the presence of light caused loss of color with time in the presence of O.

A new method of forming peptide bonds.

SHEEHAN, J. C., AND HESS, G. P. *J. Am. Chem. Soc., 77,* 1067-8 (1955).

The 2 components, 1 contg. a free carboxyl function and the other a free amino group, couple directly and rapidly in high yield on treatment with N,N'-dicyclohexylcarbodiimide at room temp.

Ultracentrifuge studies on soya bean protein.

NAISMITH, W. E. F. *Biochim. et Biophys. Acta, 16,* 203-10 (1955).

Examn. of the fractions in the ultracentrifuge at $I = 0.5$, pH = 7.8 has revealed the presence of at least 5 sedimenting components. Two of these components have been obtained in a reasonable state of purity. In both cases assocn. occurred by lowering of ionic strength, the reactions being reversible and occurring within 1 hr. The glycinin of previous workers has been shown to contain at least 4 sedimenting components.

The effect of urea on the inhibition of trypsin by soybean trypsin inhibitor.

JACOBSSON, K. *Biochim. et Biophys. Acta, 16,* 264-7 (1955).

The soybean inhibitor trypsin complex dissocs. at pH 7.6 in the presence of urea. In expts. using a casein substrate contg. urea in the same concn. as in Anson's hemoglobin method the dissocn. const. was found to be about 2.2×10^{-6} *M*.

Anhydrous hydrogen fluoride as a collagen solvent.

DREIKORN, R. E., AND O'GORMAN, V. *Nature, 175,* 385 (1955).

It is concluded that anhyd. HF does dissolve steer hide collagen, but that the soln. occurs with denaturation.

MICROBIOLOGY

A quick method for the detection of gelatin liquefying bacteria.

GREENE, R. A., AND LARKS, G. G. *J. Bacteriol., 69,* 224 (1955).

A modification of the technic of Kohn is presented.

Cooling rates and bacterial growth in food prepared and stored in quantity. I. Broth and white sauce.

LONGREE, K., AND WHITE, J. C. *J. Am. Dietet. Assoc., 31,* 124-32 (1955).

On the basis of the results, it does not seem advisable to store foods in batches larger than 2.5 gal. Holding warm food at room temp. favored bacterial growth; therefore, warm foods should not stand at kitchen temp. Refrigerator temps. of 42° F. or lower are suggested.

NUTRITION

Nutrient requirements for domestic animals. 8. Nutrient requirements for dogs.

Natl. Research Council Publ., 300, 30 pp. (1953); *Nutrition Abstr. & Revs., 25,* No. 1423 (1954).

Recommended values for the dry type diet are listed as well as suggested amts. of nutrients required per lb. of body wt. for adult maintenance and growth.

Antibiotics and nitrogen utilization in growing cockerels.

THAYER, R. H., AND HELLER, V. G. *Poultry Sci., 34,* 97-102 (1955).

An N balance study with 4 wk. old cockerels showed that penicillin and aureomycin increased dietary N retention.

The effect of antibiotics on the metabolism of nicotinic acid, biotin and folic acid in rats.

HALEVY, S., DIAMANT, E. J., AND GUGGENHEIM, K. *Brit. J. Nutrition, 9,* 57-62 (1955).

In this expt. aureomycin seemed to exert a weak sparing action on nicotinic acid, folic acid and biotin, and oxytetracycline on nicotinic acid and folic acid. Streptomycin appeared to increase the requirement for biotin and folic acid.

Effect of arginine and glycine on the growth of chicks receiving complete, purified diets.

MONSON, W. J., HARPER, A. E., BENTON, D. A., WINJE, M., AND ELVEHJEM, C. A. *Poultry Sci. 34,* 186-90 (1955).

During the first 2-3 wks., chicks growth was better on synthetic diets supplemented with arginine and glycine than with gelatin; at 4 wks., the least growth was obtained. When an antibiotic mixt. was added to the sucrose diets or when the sucrose was replaced with dextrin, gelatin supported as good or better growth than did arginine and glycine.

Life span of mice fed a high fat diet at various ages.

SILBERBERG, R., AND SILBERBERG, M. *Can. J. Biochem. Physiol., 33,* 167-73 (1955).

The effect of a high fat diet on life span depends on strain and sex of the animal tested and is specifically due to the fat content, and not to the high caloric value, of the diet. In male mice of strain $C_{57}BL$, feeding of a high fat diet from the ages of 1, 6, or 12 mos. on through life shortened the life span. If the high fat diet was given for a limited period of time, the effect on life span depended on the age at which these mice were placed on the high fat ration.

Choice of diet by rats. 3. The importance of the sense of smell in the choice of diets deficient in the vitamin B complex.

TRIBE, D. E., AND GORDON, J. G. *Brit. J. Nutrition,* 9, 1-4 (1955).

It is concluded that the sense of smell is not of crit. importance in the selection of diet.

Choice of diet by rats. 4. The choice of purified food constituents during growth, pregnancy and lactation.

TRIBE, D. E. *Brit. J. Nutrition, 9,* 103-9 (1955).

A study was made of the ability of 15 hooded Lister rats to select their diet when given a choice of the following foods: maize starch, glucose, margarine, yeast, casein, McCollum's salt mixt. no. 185 and cod-liver oil. If introduced to the free-choice routine when weighing approx. 100 g. most rats selected a diet similar in compn. to those generally recommended for use as stock diets. During pregnancy and lactation the diets selected were deficient in both cals. and protein. When introduced to the routine at weaning, young rats were totally unable to select suitable diets and almost all died.

School children in Iowa lack calcium, vitamin C.

Public Health Repts., 70, 177 (1955).

According to the findings of a 5 year statewide research program, lack of sufficient Ca and vitamin C for children was frequent. For girls 12 yrs. of age and older, lack of sufficient Fe was a frequent finding. According to analysis of finger-tip blood samples, vitamin C nutrition was found to be less than optimum for many children and actually poor for approx. ¼. A lack of carotene-rich fruits and vegetables in the diets of many children also produced results evident on analysis of blood samples. The most conspicuous phys. defect found on clinical and dental examn., was poor teeth.

Physiologic response of boys 12 to 14 years old to different breakfasts.

DAUM, K., TUTTLE, W. W., LARSEN, R., ROLOFF, L., AND SALZANO, J. *J. Am. Dietet. Assoc., 31,* 359-62 (1955).

Data were collected from 8 school boys, 12-14 years of age, designed to show the effects of the size and content of breakfast on physical and mental efficiency in the late morning hours, as exhibited by any changes which might occur in max. work rate,

(Continued on page 24)

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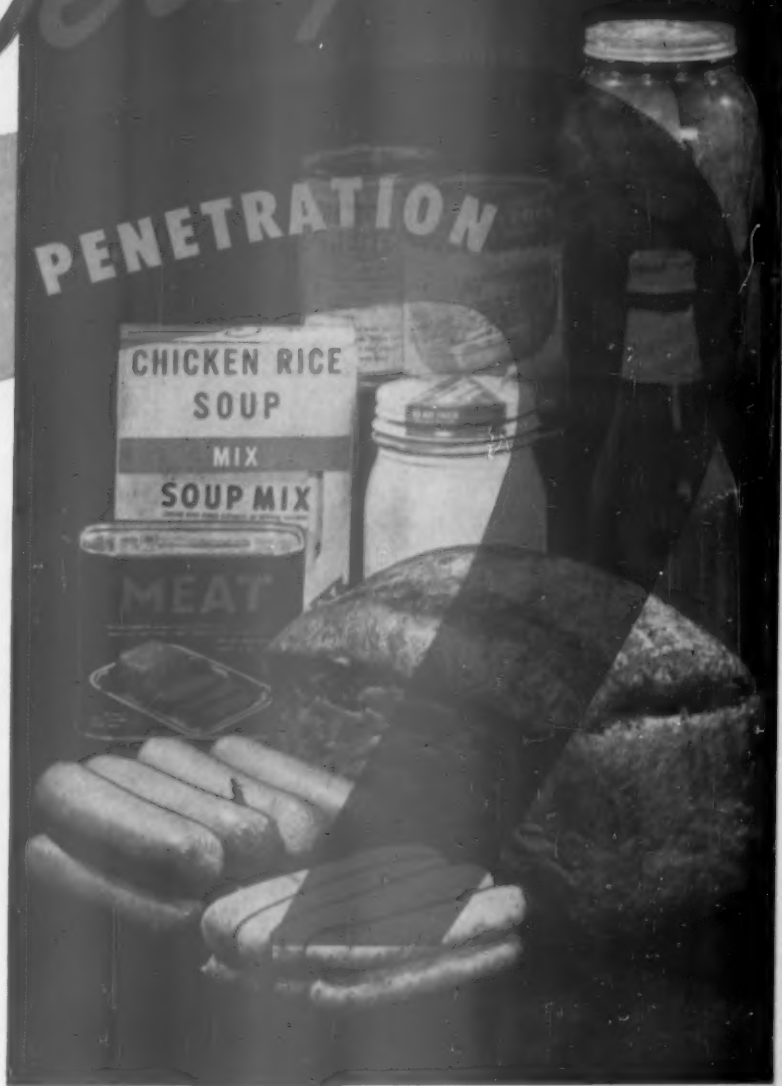

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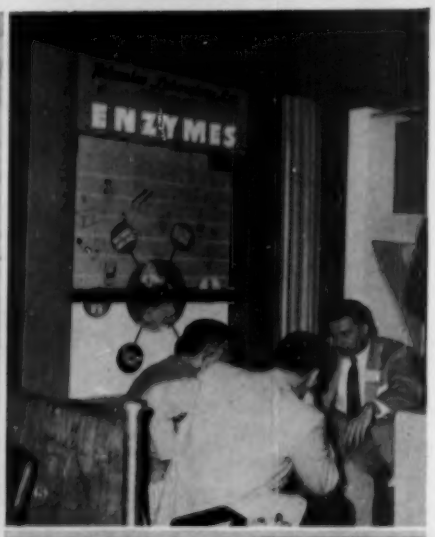

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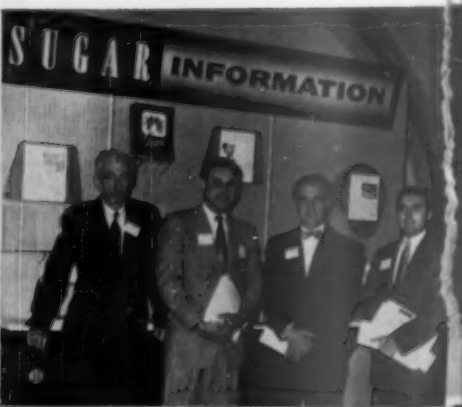

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SELECTED ABSTRACTS

(Continued from page 20)

max. work output, neuromuscular tremor magnitude, and choice reaction time. There was no differentiation by way of the physiologic responses studied after the consumption of similar basic breakfasts built around bacon, eggs, and milk and around cereal and milk.

How should the nutritionist regard additives?

MAYNARD, L. A. *J. Am. Dietet. Assoc., 31,* 329-32 (1955).

It is the purpose of this paper to consider the attitudes which nutritional scientists should take in approving the use of various food and dietary additives. Both the nutritional policy and public health will be best served by insisting on a factual basis for whatever additions are approved.

PHYSIOLOGY AND MEDICINE

Inhibition of cholesterol formation by rat liver homogenates.

MIGICOVSKY, B. B. *Can. J. Biochem. Physiol., 33,* 135-8 (1955).

The inability of liver homogenates, from starved and vitamin A deficient rats, to synthesize cholesterol is illustrated. A possible reason for this phenomenon is that these prepns. inhibit cholesterol synthesis when added to a liver homogenate from a normal rat. The inhibitory factor or factors are present in both the supernate and residue portions of the homogenate, although the residue matter is more inhibitory.

Dominant role of a simple food factor in the certain production of liver cancer in the Wistar rat consuming a carcinogen (p-dimethyl, aminoazobensene).

LE BRETON, E. *Compt. rend., 238,* 2446-8 (1954); *Nutrition Abstr. & Revs., 25,* No. 949 (1955).

This is the first report that by modification of a single dietary factor (the choline: glyceride ratio) it is possible to obtain liver cancer.

Utilization and nitrogen-sparing effect of fructose in alloxan diabetic rats.

GEIGER, E., AND PINSKY, J. J. *Metabolism, Clin. Exptl., 4,* 166-73 (1955).

The results indicate that more fructose than glucose is utilized by the alloxan diabetic rat. Furthermore, the higher utilization of fructose is not of transitory nature only, but can be demonstrated even after feeding of fructose for 25 consecutive days. It seems that the action of specific phosphorylating enzymes and some other metabolic steps which do not require the presence of insulin are responsible for fructose utilization by alloxan diabetic rats.

Slow intramolecular changes in copper complexes of serum albumin. The role of neighboring groups in protein reactions.

KLOTZ, I. M., URQUHART, J. M., KLOTZ, T. A., AND AYERS, J. *J. Am. Chem. Soc., 77,* 1919-25 (1955).

Slow changes in the spectra and properties of Cu complexes of bovine albumin have been shown to be due to metal-catalyzed reactions of an S-S linkage about 3.4 A from the sulfhydryl group of the protein.

TOXICOLOGY

Synergistic effects of aerosols. Particulates as carriers of toxic vapors.

LA BELLE, C. W., LONG, J. E., AND CHRISTOFANO, E. E. *Arch. Ind. Health, 11,* 297-304 (1955).

When aerosols are added to atms. contg. HCHO vapors, the typical effect is to increase the toxicity. Aerosols added to HNO_3 fumes tend to decrease the toxicity, while the addn. of aerosols to acrolein vapors has a variable or no effect on toxicity. When the aerosol penetration exceeds vapor penetration, toxicity is increased; when vapor penetration exceeds particle penetration, toxicity is decreased.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

The fumigation of flour with methyl bromide.

BROWN, W. B., AND REID, W. W. *Chemistry & Industry,* 324-5 (1955).

Effects produced by MeBr fumigation of flour are studied. Evaluation of deleterious effects was made on basis of presence of Br residue and/or taint after fumigation. No serious contamination noticed.

CONFECTIONERY PRODUCTS

New grade of sugar for use in candy.

Confectioners J., 81, 24, April, 1955.

A new grade of sugar has been made by the U.S.D.A. The product made by an ion exchange process is suitable for use in clear hard candies and white candies. The expected cost is reported to be 0.5¢/lb. less than refined sugar.

DEHYDRATED AND FROZEN FOODS

Halting enzymes in frozen foods.

Agr. Research, 3, 10, March, 1955.

Scientists at U.S.D.A., Western Regional Laboratory, have found that frozen peas have superior flavor and keeping quality when given a prefreezing heat treatment that completely inactivates the enzyme catalase and continues just long enough to halt the activity of a second enzyme, peroxidase.

The browning reaction in dehydrated carrot and potato: its initiation and the separation and partial characterization of an intermediate from dehydrated carrot.

WAGER, H. G. *J. Sci. Food Agr., 6,* 57-64 (1955).

The compds. that initiate the browning reaction in dehydrated carrot were shown to be sol. in H_2O or 60% alc. Alc. exts. of dehydrated carrot and potato were sepd. into basic, acidic and neutral fractions by ion-exchange resins and then heated separately and in all combinations at 30% r.h. and 52°. Browning was only considerable when the basic and neutral fractions were both present, indicating that a Maillard type of reaction is probably the first in the chain of reactions leading to browning in carrot and potato. A limited amt. of browning occurred in the basic fraction when heated by itself and this was shown to result from a colorless intermediate of the browning reaction which has been isolated and partially characterized. Its min. mol. wt. was found to be about 235 and its properties lead to the suggestion that it is an isoglycosylamine.

FLAVORING

Maple flavoring principles.

JACOBS, M. B. *Am. Perfumer Essent. Oil Rev., 65,* 52°, March, 1955.

The theories concerning the origin of the flavoring substances which give maple sirup its characteristic flavor are discussed under headings aromatic compds., amino acid-sugar complex and cyclotene. Almost all investigations agree that the flavor is due to the heating process.

GELATIN AND GUMS

Studies on a parent gelatin from ichthyocol.

GALLOP, P. M. *Arch. Biochem. Biophys., 54,* 501-12 (1955).

Mild heating of citrate-extd. ichthyocol solns. results in a breakdown of long, thin collagen protofibrils into a monodisperse parent gelatin. Viscosity, sedimentation-diffusion, and light-scattering studies indicate a mol. wt. of about 70,000 dimensions 20 x 400 A. A mechanism is proposed for the conversion.

Studies on carrageenin: comparison of fractions obtained with potassium chloride and by successive extraction at elevated temperatures.

GORING, D. A. I., AND YOUNG, E. G. *Can. J. Technol., 33,* 480-95 (1955).

Carrageenin was fractionated with KCl and by successive extns. at elevated temps. Measurements were made of sulfate content, optical rotation, gel strength, intrinsic viscosity, sedi-

(Continued on page 26)

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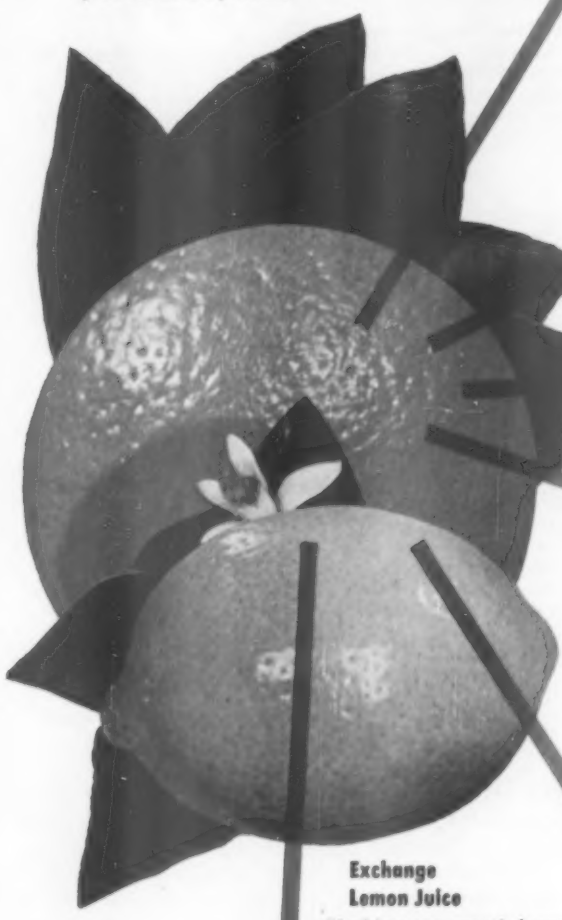

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SELECTED ABSTRACTS

(Continued from page 24)

mentation rate, and ionic mobility. The results indicated 3 components extractable at 30° C., 60° C., and 100-120° C. The 60° C. ext. had a high gel strength while the components extd. at 30° C. and 100-120° C. showed low gelling tendencies.

POTATOES

Phosphorus components of the white potato.

SCHWIMMER, S., BEVENUE, A., AND WESTON, W. J. *J. Agr. Food Chem., 3, 257-60* (1955).

Several phosphate esters have been sepd. chromatographically, and some tentatively identified as nucleotide, phytate, orthophosphate, glycerol phosphate, and occasionally the phosphates of fructose and glyceric acid. Five addnl. unknown phosphates have been detected. Orthophosphate, and not the hexose phosphates, may play a direct role in the subsequent nonenzymatic browning of processed potatoes.

Further investigations on the use of maleic hydrazide as a sprout inhibitor for potatoes.

RAO, S. N., AND WITTWER, S. H. *Am. Potato J., 32,* 51-9 (1955).

Maleic hydrazide may be successfully used as a preharvest spray for the retardation of storage sprouting in potatoes if applied to the green foliage 1-2 wks. after bloom and approx. 6 wks. before harvest.

ORGANIC CHEMISTRY

Single stage technic for epoxidation of unsaturates.

Chem. Processing, 18, 32, March, 1955.

An H_2O_2 resin technic replaces an H_2SO_4 catalyst with an acid cation exchange resin that converts the peroxide and HOAc to peracetic acid. Improves yields of epoxides.

PHYSICAL RESEARCH

Ionotropic gels from polyuronic acid. I. Structure and behavior.

THEILE, H., AND ANDERSON, G. *Kolloid-Z., 140,* 76-102 (1955).

The authors discuss many theoretical aspects of gelation and present a system accounting for types of gels formed with hydrophilic polyelectrolytes. Ionotropic gels are based on heteropolar convalent bonding; H bonding will account for some reversible gel-types.

The degradation of carrageenin. I. Kinetics in aqueous solution at pH 7.

MASSON, C. R. *Can. J. Chem., 33,* 597-603 (1955).

The degradation of carrageenin in buffered aq. soln. at pH 7.0 has been studied over the temp. range 60°-101° C. Analysis indicates the occurrence of 2 reactions. The results indicate that carrageenin is more unstable than would be expected of a simple 1-3 galactan, and that 2 types of weak linkage are involved in the structure of the polysaccharide.

Pore-size distribution in collagen and leather by the porosimeter method.

STROMBERG, R. R. *J. Research, NBS, 54,* 73-81 (1955).

The pore-size distribution in collagenous tissue and a no. of leathers, in the range 100-20,000-A. in radius, has been detd. by means of a Hg-pressure porosimeter. The sources of error incurred in such measurements, the reliability of the measurements, and exptl. and "actual" pore-size distributions are considered. The geometry of the fine and gross structure of leather, and the process of H_2O-vapor transmission through leather are interpreted from the data.

The mechanisms of bubble formation.

BOWERS, R. H. *Chemistry & Industry,* 192 (1955).

Equations are discussed which describe the mechanism of bubble formation especially as applied to fermentation processes.

RADIOCHEMICAL TECHNOLOGY

Radioactive tracing. Part I. The nature of radioactive isotopes and their production.

WINTERINGHAM, F. P. W. *Lab. Practice, 4,* 93-102 (1955).

These articles are designed as a general and comprehensive introduction to the subject. Covered in this section are: atomic structure, radioactive decay, the artificial formation of radioisotopes, pile-produced radioisotopes, yields of radioisotopes in the pile and a fairly complete table of readily available radioisotopes.

MISCELLANEOUS INFORMATION

Introduction to technical writing. Part I. The general preparation of the manuscript.

BANNER, E. H. W. *Lab. Practice, 4,* 106-9 (1955).

These articles deal with tech. writing for various purposes including special typing and other instructions in prepn. for publication in different ways, for students in science and technology. They form an introduction to more detailed publications. Four more articles are to appear later.

A bookshelf on foods and nutrition.

SHANK, R. E., AND MRAK, E. M. *Am. J. Public Health, 45,* 419-28 (1955).

The authors have attempted to select from a large no. of books and articles on foods and nutrition those of particular importance for professional workers in the health sciences.

PATENTS

Production of precooked alimentary paste products.

POOLE, R. S. Assignor to Kellogg Co. 2,704,723, March 22, 1955.

A method for the production of dried alimentary paste compn. food products which comprises, extruding an alimentary paste compn. to desired form, cooking it in H_2O at a temp. of about 212° F. for about 2 mins., draining the cooking H_2O therefrom and immediately drying it.

Dehydration of potatoes by diffusion.

HEISLER, E. G., AND HUNTER, A. S. Assignors to the U. S. A. 2,704,260, March 15, 1955.

A process of dehydrating cooked mashed potato comprising mixing the potato with about 0.5 to 1 part of EtOH per part of potato thus to form a semiliquid slurry, placing the slurry in a regenerated cellulose film container having a wall thickness of about 1-2 mils, exposing the container to a current of air for a sufficient time to permit diffusion through the walls of the container and evapn. of at least about 60% of the H_2O in the slurry, and recovering the potato solids from the slurry.

FIRST CALL FOR 1956 ANNUAL MEETING PAPERS

Out of St. Louis comes the opening note that sounds the advent of the sixteenth annual meeting of IFT—the first call for papers.

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The following sessions are tentatively scheduled: dehydration; canning; fermentation; irradiation; frozen foods; food engineering; new products and practices; citrus products; cereals; meat; fruits and vegetables; sensory testing; microbiology; packaging; and general. A symposium honoring the fiftieth anniversary of the Food and Drug Law is planned; the speakers will be invited to participate in accordance with their knowledge of a special phase of Food and Drug Law history and progress.

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Barnett Laboratories, Long Beach, California

(Manuscript received March 12, 1955)

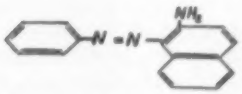
A study was made of the methods of assaying the pigments found in commercial butter and margarines. A procedure was developed for the detection of annatto extract or "certified" coal tar colors which are added to these products. It was found possible to quantitatively assay these constituents along with carotene and other carotenoids without the necessity of saponifying the oils. Carotene and annatto extract were determined by means of a chromatographic separation while the "Certified" dyes were separated by means of an acid extraction procedure.

Analysis of a number of samples of butter by this method demonstrated that a good share of the butter produced in this country is artificially colored and that the coal tar dyes are the coloring most widely used. The strength of coloring employed, however, is somewhat less than that found in summer butters.

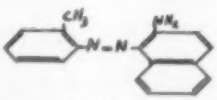
During the course of work in our laboratory, it became of interest to be able to differentiate between the various pigments found in the butter and margarine sold in the open market. The principal pigment in butter is beta carotene but during the period of the year that butter is low in pigment, it is customary to add artificial coloring. Margarine, of course, is essentially colorless and therefore all the yellow coloring must be added during processing.

In this country, three oil-soluble coloring materials are used for this purpose, namely the "certified" colors, yellow AB and yellow OB, annatto extract, and carotene. Insofar as is known, annatto extract is not being used in this country for coloring margarine.

The Certified dyes, F. D. & C. yellows 3 and 4 (yellow AB and yellow OB), are usually mixed together. They have a very similar chemical structure:



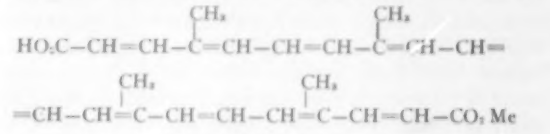
F. D. & C. Yellow No. 3
(Yellow AB)



F. D. & C. Yellow No. 4
(Yellow OB)

These products are supplied to the butter industry in an oil solution containing 2.5-4% dye. Some margarine processors prepare their own solutions from the pure dyes.

The annatto extracts are also supplied to the butter industry in an oil solution. This pigment is derived from the seeds of the annatto bush *Bixa Orellana*. The principal pigment is bixin, whose structure is shown below:



Bixin

This carotenoid has no vitamin A activity.

The carotene which is offered to the butter industry is generally a saturated solution of commercial carotene crystals in vegetable oil. For margarine processors, carotene is supplied in the form of a stable suspension of micro crystals of carotene in vegetable oil which dissolves readily when added to warm oil.

The absorption curves of these pigments dissolved in vegetable oil are shown in Figure 1. Although the shape of the absorption curves for bixin and carotene appear to be quite similar, the proportion of red to yellow color is greater in bixin than in beta carotene. This is not serious when coloring butter since the carotene already present in the butter helps to bring the color to one approaching a normal shade.

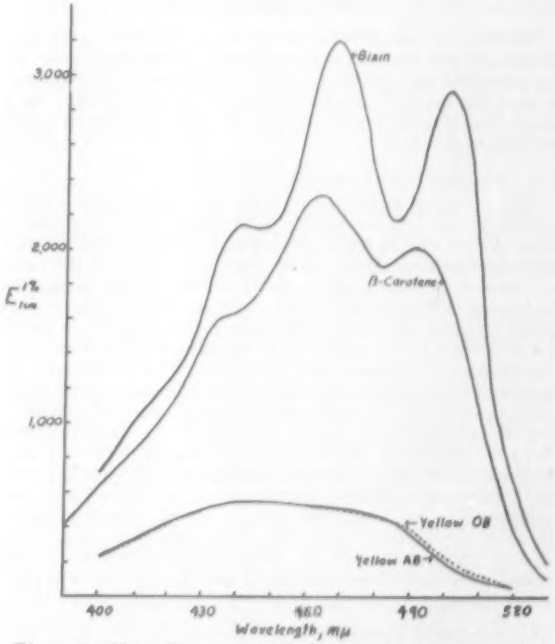


Figure 1. Absorption curves of pigments in cottonseed oil.

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, June 29, 1954.

Despite the small difference in the curves for yellow AB and OB, there is a distinct difference in the coloration of yellow margarine colored with each. The former produces a margarine colored a lemon yellow whereas the latter will give a reddish tinted margarine reminiscent of that made with bixin. Blends of the two dyes give a coloring similar to that of carotene. It will be noticed also that at the point of maximum absorption, there is very little difference in the extinction coefficient of the two dyes.

The purpose of this work was to develop a simple method for determining these three classes of pigments in a sample. It was observed that when samples of butter oil were chromatographed on magnesia columns, a separation of the carotene from the artificial colors could readily be achieved. Further, when the column was topped with some sodium sulfate as a drying agent, some of the annatto pigment was held back on the desiccant, certified colors were held near the top of the magnesia column while the carotene could be recovered quantitatively in the filtrate. Further investigation showed that the lot of sodium sulfate being used as a desiccant was slightly alkaline. When a new lot was substituted which had a pH slightly lower than 7, then no absorption of annatto pigment took place. Modifications of this technique provided a satisfactory method for the analysis of carotene and annatto. However, a separation with strong acid solutions was found preferable for the "certified colors."

EXPERIMENTAL

Method. A cube of butter or margarine is melted in a warm water bath and the oil is centrifuged off. About 30-35 g. of the oil is weighed out and made to 100 cc. in hexane. This solution is used for the various tests. Although the oil produced by a simple centrifuging is often turbid, this does not interfere with the determination.

(a) *Identification of pigments:*

The sample is tested for artificial color by shaking a small portion of the 30% oil solution with concentrated hydrochloric acid. A red color in the aqueous phase is indicative of the coal tar colors yellow AB and OB. Another portion of the same oil solution is shaken with a small amount of 5% ammonium hydroxide in 55% ethyl alcohol. A straw color in the aqueous phase indicates that annatto has been added. Further, if yellow color remains in the petroleum phase after both of these tests, the presence of carotene seems probable. The behavior of the pigments on the magnesium oxide column is also very revealing as to their identity. Annatto behaves characteristically in coloring the very top of the column with a brick color which remains fixed throughout the elutions. The certified colors form a band near the top of the column and will migrate very slowly during the course of the elution. Occasionally, a slight separation presumably into its 2 pigments will be noted. Carotene passes through the column with very little resistance while other natural carotenoids such as xanthophyll are held back until eluted with more polar solvents. If they are present in appreciable quantity, they can be collected and assayed.

(b) *Analysis of Carotene:*

A chromatographic tube, 15 x 150 mm. is fitted into a 50 cc. filter flask. The column is packed to a depth of 4-5 cm. using a moderate vacuum with an adsorbent consisting of 50% magnesium oxide (Westvaco No. 2642) and 50% filter aid (Johns-Manville Hi-Flo Super Cel). Then 15 cc. of the oil solution are added. Without allowing the column to dry, the column is rinsed with a total of 30 cc. of 9:1 hexane:acetone, adding it in successive small portions. When nearly all the solvent has been drawn into the column, the eluate is collected and transferred to a 50 cc. volumetric flask. Should there be an appreciable quantity of pigments other than artificial colors remaining in the column, these can be eluted with 7:3 hexane:acetone and collected in a 10 cc. volumetric flask.

The solutions are made to volume and read at 450 mμ on the spectrophotometer. The carotene content is calculated using an $E^{1\%}_{1cm.}$ of 2520 for pure beta carotene *(2)*. The extraneous pigments are calculated using the same extinction coefficient as for beta carotene.

(c) *Analysis of Coal Tar Colors:*

The combined content of yellow AB and OB is determined by pipetting a 15 cc. aliquot of the oil solution into a cold 60 cc. separatory funnel containing an equal volume of hexane and extracting it 3 times with 5 cc. portions of ice cold 60% by weight sulfuric acid. Each portion of the acid is shaken with the solution, separated, and drained into another separatory funnel containing about 50 cc. of ice water along with about 50 cc. of ethyl ether. It is essential that these manipulations be carried out as expeditiously as possible, since the dyes are slowly decomposed by the acid solution.

After thorough shaking, the diluted acid is discarded and the ether layer is then washed twice with dilute ammonium hydroxide and finally with water until neutral. The solution is filtered through sodium sulfate into a small Erlenmeyer flask, and the solution and washings are evaporated on a steam bath until substantially free of solvent. The residue is dissolved in cyclohexane and transferred quantitatively to a 10 cc. or 25 cc. volumetric flask. The solution is read at 435 mμ and the concentration of dye in the butter or margarine is calculated on the basis of an $E^{1\%}_{1cm.}$ of 585 for the pure dye *(7)*.

(d) *Analysis of Annatto Extract:*

A 15 x 150 mm. chromatographic column is fitted with a plug of glass wool at the bottom and then packed to a depth of about 3-5 cm. with a mixture of 1:1 powdered sodium carbonate and Hi-Flo super cel. A 15 cc. aliquot of the butter oil solution is then drawn in followed by a 10 cc. rinse with hexane and a 10 cc. rinse with acetone. When the acetone has been drawn through the column, 10 cc. of 70% ethyl alcohol in water are added. This immediately elutes the bixin as its sodium salt and it is very easy to follow its progress down the column. When the pigment has arrived near the bottom of the column, collection of the annatto fraction is commenced. The eluate is collected in a 10 cc. volumetric flask and made to volume with 70% alcohol. Should there be any turbidity, the solution must be filtered through a sintered glass funnel prior to spectrophotometric assay. The bixin content is calculated using an $E^{1\%}_{1cm.}$ of 3200 at 455 mμ.

When working with annatto, one must exercise the greatest care not to allow the solutions to come inadvertently in contact with cotton, filter paper, or any alkaline substance that might absorb the pigment. Thus, it is generally necessary to use all-glass apparatus.

DISCUSSION

(1) *Carotene:*

Because of its importance in nutrition, a considerable amount of work has been carried out on the analysis of carotene in butter. At the instigation of the National Research Council, a standard method of analysis was proposed and collaborative assays were conducted *(6)*. In this method, the oil was saponified and the unsaponifiable fraction was extracted with 90% methanol to remove xanthophylls and artificial colors. In an extensive survey of the vitamin A potency of butter, carotene was analyzed by a similar technique except that the unsaponifiable fraction was extracted with 92% methanol or 94% diacetone alcohol. The methods used were described in detail by Jenness and Palmer *(5)*, and the results were described in publications of the U. S. Department of Agriculture *(13, 14)*. Recently, the determination of carotene in yellow margarine containing

TABLE 1
Recovery of added carotene

Carrier oil	Carrier oil pigment	Weight, grams	Input carotene in sample, mcg.	Added carotene, mcg.	Total input carotene, mcg.	Total recovered mcg.	% recovery
Yellow margarine	carotene	3.54	38.5	32.5	71.0	68.8	97.0
Yellow margarine	carotene	3.54	38.5	48.8	87.3	85.0	97.4
White margarine	none	5.86	0	87.5	87.5	85.0	98.1
Butter oil	carotene	5.99	29.6	67.0	96.6	96.0	99.3
White margarine	none	5.45	0	61.4	61.4	60.5	98.5
Yellow margarine	coal-tar colors	6.11	0	61.4	61.4	59.4	96.6

this material was described in detail by Luckmann and coworkers *(7)*.

Wishing to avoid the tedious saponification required for these procedures, we attempted to apply the standard A.O.A.C. method for carotene analysis in plants *(10)* using the oil solution itself and making the necessary adaptations and adjustments reequired because of the very dilute solutions of carotene involved. By avoiding saponification and liquid extraction, the speed and accuracy of the assay could be substantially increased and the danger of isomerization of the carotene could be avoided.

Because of the low concentration of the carotene in butter and margarine, the extraneous color of the oil becomes a factor in attempting to read these solutions directly on the spectrophotometer. Although the chromatographic technique removes the bulk of this background absorption, a small amount of pigment still remains when margarine is chromatographed. Tests made using margarine not colored with carotene indicate that the remaining background absorption is of the order of 0.4 p.p.m. calculated as carotene. It was impossible to check this directly on butter as such.

The carotene method was tested by preparing synthetic samples, using white margarine as a carrier and adding known quantities of carotene to it. Similar tests were carried out using margarine known to be colored only with coal tar dyes and to which known quantities of carotene were added. To other samples of known carotene content, increments of carotene were added and the recovery was checked. The results are shown in Table 1.

A number of samples of butter along with some margarines known to be colored with carotene were assayed for carotene by the chromatographic method along with the method of saponification and extracting with 90% methanol (Table 2).

It will be seen that the saponification method gives carotene values that are somewhat higher than those obtained by the chromatographic method. However, this is not unexpected since the chromatographic technique employed would be considerably more selective for carotene than would be the saponification-liquid extraction procedure. Actually, Berl and Peterson *(1)* had chromatographed the unsaponifiable fraction of butter and found that non-carotene pigments still remained after liquid extraction of the unsaponifiable fraction. Similar experiences were reported by Goodwin and Morton *(4)* when they chromatographed the unsaponifiable fraction of butter using a column of solvent extracted bone meal as suggested by Mann *(8)*. It is felt, therefore, that particularly in the case of butter, the chromatographic method is more accurate than the saponification-liquid extraction procedure.

TABLE 2
Carotene determinations by chromatographic and saponification methods

Sample number	Carotene content of oil, chromatographic method, p.p.m.	Carotene content of oil, saponification method, p.p.m.	Ratio chromatographic/ saponification
4-173 (butter)	7.50	7.80	0.963
4-174 (butter)	5.07	5.71	0.889
4-177 (butter)	4.98	5.54	0.901
4-183 (butter)	9.61	9.65	0.996
5-67 (butter)	5.10	5.67	0.900
5-66 (margarine)	10.1	10.3	0.980

(2) *Coal Tar Colors:*

Initially it appeared that it would be feasible to elute the coal tar dyes from the magnesia column once the carotenoids had been removed. However, whereas this could be done after the absorbent had been stored in partially full containers for some time, it was impossible to quantitatively elute the pigment from a column of freshly prepared adsorbent. The possibility of using simultaneous equations to determine the coal tar dyes in the presence of carotene was considered but it was felt that its accuracy would be questionable.

Although the A.O.A.C. *(10)* has a method for the separation and identification of the oil soluble coal tar dyes, Zscheile and coworkers *(15)* were unable to obtain good recoveries of the dyes when working with butter. Our experience with this technique confirms their findings.

It was found that in using sulfuric acid to separate the coal tar colors from the other pigments, a minimum concentration of about 60% by weight was required in order to remove the dyes from the hexane solutions. Further, it was found that in these strongly acid solutions, the dyes slowly decomposed and the rate of decomposition was related to the temperature of the solutions being used. Therefore, by using ice cold reagents and apparatus and by carrying out the acid processing as expeditiously as possible, good recoveries of yellow AB and OB could be attained. Table 3 shows the recoveries of yellow AB and OB obtained by this method. While some of the recoveries, particularly with yellow OB, were not as good as could be desired, it was felt that they were still adequate for most purposes.

(3) *Annatto Butter Colors:*

In order to establish the method for the determination of annatto in butter, samples of annatto butter colors were procured directly from several manufac-

TABLE 3
Recovery of coal tar dyes

Dye	Wt. of added white oleo oil	Input dye, mcg.	Recovery, mcg.	Percent recovery
Yellow AB	6.0 g.	43.1	43.9	101.5
Yellow AB	5.25	39.5	40.9	103.0
Yellow AB	0	39.4	37.6	95.5
Yellow AB	0	35.6	35.6	100.0
Yellow AB	0	193.0	194.0	100.0
Yellow AB	0	193.0	197.0	102.0
Yellow OB	6.0	36.2	34.5	95.4
Yellow OB	5.25	35.8	31.2	87.0
Yellow OB	0	40.7	36.1	88.6
Yellow OB	0	192.0	180.0	93.6
Yellow OB	0	192.0	190.0	99.0

turers and also by purchase through the regular commercial channels. The absorption curves of several of these samples are shown in Figure 2, the solvent in all cases being acetone. Included in the figure is the absorption curve for bixin in the same solvent. This

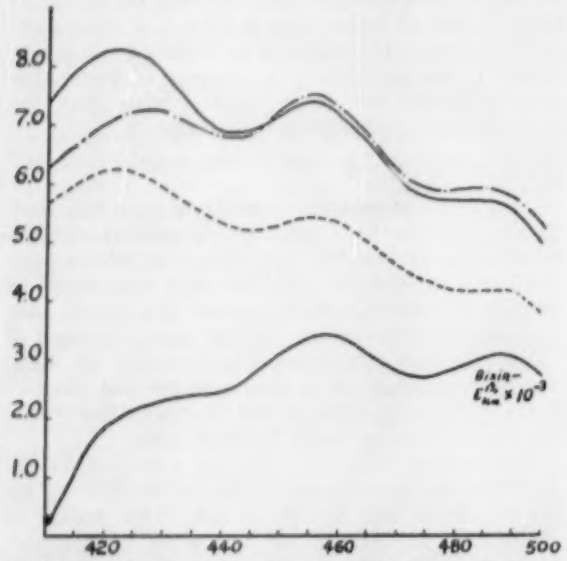


Figure 2. Absorption curves of commercial annatto butter colors in acetone.

pigment was isolated from one of the butter colors obtained for this study. It is evident that there is a marked variation among the curves of various butter colors and that these commercial preparations contained a considerable amount of pigment other than pure bixin.

Table 4 shows the recoveries when various different lots of annatto butter colors were processed by the

TABLE 4
Recoveries of annatto butter colors by alkaline absorption procedure

Sample	$E^{1\%}_{1cm.}$ @ 455 mμ originally	$E^{1\%}_{1cm.}$ Recovered	Percent Recovered
Brand A	7.46	7.13	95.6
Brand A	7.77	7.11	91.5
Brand B	7.51	7.21	96.0
Brand B	7.70	7.02	91.2
Brand C	5.34	4.79	89.7
Brand C	10.01	3.73	37.3[1]
Brand D	6.48	5.94	91.7

[1] Although this sample was labeled "Annatto Vegetable Color," analysis showed that it contained only about 37% annatto extract and the balance was Coal-Tar Dyes.

alkaline separation procedure. The annatto butter colors consist largely of a mixture of carotenoid carboxylic acids but there is apparently a small amount of non-acidic pigment which is not captured by the alkaline adsorbent. This probably accounts for the variation in recovery from one lot to another.

Actually brands A and B represent the bulk of the annatto extract sold in this country. On the basis of these assays, their average color content calculated as bixin is 0.24%.

When the annatto pigments are eluted from the column with 70% alcohol, they are removed as the sodium salt of the carboxylic acid. However, as pointed out by Luckmann and coworkers *(7)*, the absorption curve of the sodium salt is similar to that of the parent carboxylic acid.

Prior to discovering the feasibility of adsorbing and eluting the annatto pigments from an alkaline column, a liquid extraction procedure was employed using dilute ammonia in 55% alcohol as a separating medium. However, it was considerably more cumbersome than the method finally used.

APPLICATION TO COMMERCIAL BUTTERS AND MARGARINES

Assessing the relative coloring value of the 3 types of coloring materials is difficult. If it were assumed that the coloring value of the various pigments was directly proportional to the extinction coefficient at the maximum, then one gram of carotene should give the same color intensity as 4 g. of mixed coal tar dyes or 0.7 g. of bixin. Actually, if margarine were to be made up with this proportion of colors, the product made with carotene would be the lightest in color with the sample colored by the coal tar colors somewhat stronger in pigmentation and the bixin-colored product considerably darker. From visual comparisons, it seemed that one gram of beta carotene is equivalent in coloring power to ½ g. of bixin or 3⅓ g. of coal tar colors.

Using these ratios for the pigmentation value of these pigments, an arbitrary "color score" was assigned to the samples tested. This was based on the assumption that a butter or margarine containing a color equivalent to 9 p.p.m. of carotene would most closely match consumer preference. A "color score" of 100 was assigned to such a color and samples were then graded on their relative amounts of coloring.

In Table 5 is shown the composition of butter samples collected in the Los Angeles area over a period of time. Unfortunately, the amount of carotenoids other than carotene was not determined on these samples. Had they been determined, it would probably have raised the "color score" by about 5%.

A number of samples were collected in Kansas City, Missouri, in April, 1954, and analyzed by these methods (Table 6).

Samples were also obtained from two other areas in Colorado and South Dakota during April 1954. These assays are shown in Table 7.

In Table 8 is shown a summary of the results obtained in the preceding 3 tables. Although these samples do not represent a complete cross-section of the butter

TABLE 5
Butter samples, Los Angeles area

Sample number	Date	Carotene p.p.m.	Bixin p.p.m.	"Certified" dyes, p.p.m.	% of color due to carotene	"Color score"
147	7/53	1.6	1.7	0	32	56
148	7/53	5.9	0	0	100	65
149	7/53	6.8	0	0	74	76
150	7/53	6.8	0	0	100	76
125	7/53	10.2	0	0	100	113
126	7/53	7.2	0	0	100	80
127	7/53	4.9	0	9.0	65	84
128	8/53	6.2	0	0	100	69
129	8/53	6.3	0	0	100	70
131	11/53	1.5	0	5.0	50	33
133	11/53	3.9	0	4.6	74	59
138	11/53	5.3	0	10.9	61	95
135	12/53	5.0	0	15.5	52	107
136	12/53	5.1	0	14.6	54	105
137	12/53	5.7	0	7.9	70	90
139	12/53	10.0	0	0	100	111
140	12/53	5.0	0	11.3	59	93
143	12/53	5.5	0	0	100	61
144	12/53	4.6	0	9.2	62	82
141	1/54	5.3	0	11.4	61	97
142	1/54	4.3	0	5.9	71	68
145	1/50	4.1	0	7.4	65	70
146	1/54	5.1	0	0	100	57
109	4/54	11.7	0	0	100	130
102	5/54	4.4	0	19.2	43	113

produced in this country throughout the year, we consider that they are indicative of the extent and type of coloring being employed by the industry.

Table 9 shows assays carried out on commercial margarine samples purchased locally. The variation in total coloring between brands was quite surprising inasmuch as this product is quite carefully controlled. The average color score is close to the average of that found in the butter samples.

TABLE 6
Missouri butters, April 1954

Sample number	Carotene p.p.m.	Other carotenoids p.p.m.	Bixin p.p.m.	"Certified" dyes, p.p.m.	% of color due to carotene	"Color score"
110	3.5	0.40	0	10.6	49	77
111	3.8	0.67	0	8.0	55	76
112	2.7	0.23	0	6.9	54	56
113	2.6	0.37	0	12.1	39	73
114	1.9	0	0	0	100	21
115	2.7	0	0	10.9	45	66
116	2.5	0.38	0	9.28	44	63
117	4.8	0.48	0	8.4	62	87
118	2.8	0.37	0	5.32	59	53
119	2.4	0.50	0	13.3	35	77
120	2.4	0.38	0	7.1	49	55
121	2.2	0.40	0	11.9	36	69
122	1.8	0.51	0	9.68	35	58
123	4.2	0.56	2.28	0	45	104
124	2.6	0.50	0	15.4	34	86

In applying these methods to numerous samples of margarine, two instances have been found wherein products labeled as colored with carotene in actuality contained coal tar dyes.

Although all of the data shown here referred to the pigments in butter and margarine, this method is probably also applicable to food products such as popcorn oil, cake mixes, noodles, and other foods containing oil soluble yellow pigments.

TABLE 8
Summary of butters analyzed
(California, Colorado, Missouri, South Dakota)

Number of samples assayed	47
Total number with artificial coloring	36
Total containing "certified dyes"	32
Total containing annatto butter colors	4
Average carotene content	4.4 p.p.m.
Average "certified" dye content (32 samples)	10.0 p.p.m.
Average bixin content (4 samples)	1.66 p.p.m.
Average percent of color due to carotene in artificially colored samples	52%
Average "color score" of all samples (9.0 p.p.m. carotene = 100)	76.4

TABLE 9
Analyses of coloring agents in margarine

	Pigment	Pigment content of margarine, p.p.m.	Color score
Brand A	Carotene	7.7	86
Brand B	Carotene	8.4	93
Brand C	"certified" dyes	24.2	81
Brand D	"certified" dyes	19.8	66
Brand E	"certified" dyes	23.9	80
Brand F	"certified" dyes	21.8	73
Brand G	"certified" dyes	31.4	105
Brand H	"certified" dyes	25.0	83
Average			83

SUMMARY

A method has been developed for the detection and quantitative estimation of the principal pigments found or used in commercial butters and margarines. Mixtures of carotene, annatto extract, and coal tar colors can be separated and analyzed individually without the necessity of saponifying and extracting the oil carrier. A number of samples of butter and margarine were analyzed by these methods for type and strength of coloring materials.

Acknowledgment

The assistance of Amy H. Newberry in carrying out many of these tests is gratefully acknowledged.

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TABLE 7
Colorado and South Dakota butters, April 1954

Sample number	Source	Carotene p.p.m.	Other carotenoids p.p.m.	Bixin p.p.m.	"Certified" dyes, p.p.m.	% of color due to carotene	"Color score"
101	S. Dak.	2.4	0	0	21.2	27	97
103	S. Dak.	2.5	0	0.8	0	61	46
104	S. Dak.	1.9	0.26	1.82	0	33	65
105	Col.	3.3	0.44	0	7.5	55	67
106	Col.	3.1	0.40	0	6.8	56	59
107	Col.	3.5	0.55	0	14.0	42	92
108	Col.	3.0	0.39	0	5.9	58	57

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Effect of Fluctuating Temperatures on Frozen Turkeys

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The effect of fluctuating temperatures on the quality of frozen turkeys was examined with reference to moisture losses, chemical changes, and palatability. It is concluded that moisture loss is affected by fluctuation as compared with average temperature. Off flavor development occurred in 12 months' storage but could not be specifically related, within the error of measurement, to temperature fluctuation. Appearance of the product is affected by the accumulation of frost within the package but the eating quality is not thereby impaired.

In normal channels of utilization, poultry is subjected to complex patterns of temperatures *(5)* and temperature variations as it proceeds through chilling, freezing, warehouse storage, transportation, and holding in retail display cases and home refrigerators. The importance of low-temperature storage for quality maintenance is well recognized *(4, 8)*. The effects of variations in temperature on quality of turkeys have received very little attention. The question arises, is storage under fluctuating temperature conditions more detrimental to quality than storage under steady temperature conditions? Although an answer to this question for a limited temperature range is a principal object of this study, considerable information will be reported on steady temperature storage.

The complexity of the problem is multiplied by many factors that influence stability other than temperature. These include species, age, composition of carcass fat, degree to which surface is exposed, processing factors, and packaging. This study has included birds scalded in two ways, packaged in three ways, stored at steady temperatures of —30°, 10°, 0°, and +10° F. and stored under a fluctuating temperature condition consisting of a continuous 24-hour cycle between —10° and +10° F. Moisture losses, chemical changes, and palatability changes were determined. No work of this type on turkeys has come to our attention and only limited results on chickens are available. Parnell, Butler, and Cover *(6)* investigated the effect on unwrapped half fryers of a temperature-varying condition consisting of the following: 12 hours at 0° F. followed by 12 hours in which the temperature fluctuated every 1½ to 2 hours from 2° F. to +15° F. and back to 2° F. Fryers were also held at each of three constant temperatures, 0° F., 7° F., and 15° F., for comparison. The mean of all temperatures for the fluctuating condition over a complete 24-hour cycle would fall at some value intermediate between 0° and 7° F. After 3- and 6-month periods under these conditions, losses in weight (moisture) at the fluctuating temperature condition approximated those at the 7° F. constant-temperature condition. No pronounced off-flavors were recorded in any case. The earlier work of Gortner *et al. (1)* and of Hustrulid *(2)* on pork and beef products show, as we might expect, a greater moisture loss under fluctuating conditions, but in their case greater flavor deterioration also occurred.

In our studies with turkeys, which are less stable than chickens, off-flavor development occurred in 12 months' storage, but the extent of development was not specifically affected by the fluctuating condition within the

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error of measurement. Moisture loss, however, was affected by the fluctuation as compared with the average temperature.

EXPERIMENTAL PROCEDURE

Seventy-two Broad Breasted Bronze young tom turkeys were selected for uniformity from a commercial lot and processed at a typical turkey dressing plant. Twelve birds were scalded in a small drum at 140° F. for 30 seconds, the remainder in the regular plant scalder at 126° F. for 45 seconds. After passage through a conventional line of picking machines and a manual pinning operation, the dressed birds (average weight 24 lbs.) were transported in finely crushed ice to the laboratory, where they were eviscerated, packaged in evacuated, twist-sealed, polyethylene bags, and frozen in a blast tunnel at —30° F. The frozen turkeys were stored at —10° F. for 7 weeks before assigning to experimental groups, weighing, repackaging, and storing at the selected experimental temperatures. Initial weights were recorded with and without the experimental packaging material in order to permit subsequent determination of moisture losses from the bird both through the package and held within the package as frost.

Experimental treatments and storage conditions for the various groups are listed in Table 1. Each group contained 6 turkeys selected at random from turkeys scalded at the same temperature. Film of the polyethylene bags was 0.0015 to 0.002-inch thick, aluminum foil was 0.0015-inch thick; the wax paper was 0.003-inch thick with a base weight of 35 lbs. per ream (500 sheets 24 x 36 inches) and a wax coating on both sides, totaling 17 lbs. per ream. Polyethylene bags were evacuated by means of a water aspirator before the ends were twisted and tied. Packaging in aluminum foil was accomplished by a butcher wrap with a 27 x 36-inch sheet of the foil, with gentle pushing to conform to the shape of the bird. Turkeys were wrapped in 36 x 39-inch sheets of wax paper (butcher wrap) and the edges secured with cold-storage locker tape.

Packaged turkeys were stored on wall shelves in low-temperature rooms accurately controlled to the temperatures listed in column 4, Table 1. The fluctuating-temperature condition consisted of a sine wave cycle fluctuating between —10° F. and +10° F. and repeating itself every 24 hours. In all rooms the air was drawn up through a central duct, passed over the refrigeration coils, and then distributed to double walls which were perforated to permit a uniform flow of air over the packages on the wall shelves. Rate of air flow about each packaged turkey was approximately the same, ranging from 30 to 40 feet per minute. A pilot turkey, containing thermocouples at various depths below the skin surface, was placed in the room fluctuating between —10 and +10° F., and the temperatures were recorded on a potentiometer-thermocouple recorder.

After 6 months under the various conditions, determinations were made of moisture loss from the package. After 12 months, a complete evaluation was made of 5 turkeys in each group, which included measurement of moisture loss out of the package, frost accumulation inside the package, changes in surface appearance due to moisture loss, extent of chemically detectable rancidity (peroxides) in the fat, and organoleptic appraisal of roasted turkeys for rancid off-flavors or other quality defects. Observations and tests on one turkey per group were made after 18 months to detect any maked changes in trends or differences observed at 6 and 12 months.

Frost accumulation as measured in this study was considered to include that portion of the moisture lost from the carcass that was retained within the package plus the discrete ice crystals that could be easily scraped from the skin and visceral cavity of the bird. Determination of peroxide values in the raw fat was made according to a modification of Wheeler's iodometric method *(7)*. For organoleptic appraisal, the frozen turkeys were sawed into quarters, thawed at room temperature over a period of 15 hours, and roasted in a 300° F. rotating electric oven to an internal temperature of 180° F. for the front quarters and 185° F. for the rear quarters. Only 4 experimental groups were compared at any one time. There were at least 4 replications of each judging by a trained panel of 7 persons. At any one tasting period, roasted light meat and skin of the front quarters, or dark meat and pan drippings of the rear quarters, were ranked for rancidity (1 signifying least rancid and 4, most rancid).

RESULTS AND DISCUSSION

The manner in which product temperatures followed room temperature under the selected fluctuating temperature condition is presented in Figure 1. While the

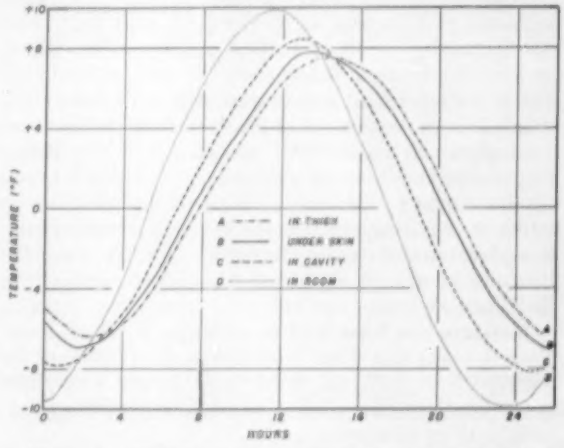

Figure 1. Typical record of temperatures at various locations in the fluctuating temperature room over a 24-hour period. A. In flesh of thigh at a depth of about one inch. B. Just under the skin in the breast region. C. In the visceral cavity. D. In the room.

TABLE 1

Average moisture losses in percent of carcass weight

Group	Scald temp.	Packaging	Storage temp.	6 month loss out of package	12 month loss	
					Out of package	In package as frost
	° F.		° F.	%	%	%
12	126	Polyethylene bag	—30	<0.05	<0.05	<0.05
1	126	Polyethylene bag	—10	<0.05	<0.05	0.07
2	126	Polyethylene bag	0	<0.05	<0.05	0.17
3	126	Polyethylene bag	+10	<0.05	0.10	0.20
4	126	Polyethylene bag	—10 to +10	<0.05	<0.05	0.33
6	126	Wax paper	—10	0.7	1.0	<0.05
7	126	Wax paper	0	1.0	1.8	0.06
8	126	Wax paper	+10	1.6	2.4	0.07
9	126	Wax paper	—10 to +10	1.2	2.2	0.09
10	126	Aluminum foil	0	0.22	0.57	<0.05
11	140	Aluminum foil	0	0.21	0.54	0.06
5	140	Polyethylene bag	0	<0.05	<0.05	0.29

re-circulating air issuing from the perforated double walls of the room varied as intended over the complete 20° range (—10 to +10° F.), the air temperature near the packaged turkeys covered a slightly smaller range (not shown in Figure 1) and the range in the most insulated spot (1 inch in the thigh) was reduced to about 14°. The magnitude of the time lags behind room temperature increased, of course, with the degree of insulation and was greatest, about 3½ hours, for the thigh temperature.

Moisture loss from package. Data on moisture losses (Table 1) indicate a greater moisture retention for a sealed polyethylene bag compared to a wax paper wrap, and an intermediate value for an aluminum foil wrap as it was employed in this experiment. In this and subsequent comparisons of packaging materials or methods, the stated conclusions should not be interpreted as commercial evaluations or recommendations of a particular packaging material or method, but only as indications of the manner in which processed poultry is influenced by environment including within-the-package humidity and temperature conditions.

Moisture losses through the package were negligible for sealed polyethylene, an example of a relatively moisture impermeable package. Losses through wax paper increased with increase in temperature, with the loss at the fluctuating (—10 to +10° F.) temperature falling between the losses at 0 and +10° F. Interpolated estimates of the constant temperature that will produce the same effect in the product as the fluctuating temperature are subject to considerable error, due to variability between turkeys and the availability of values for only three constant temperatures. With these limitations in mind, the data suggest that the fluctuating temperature is equivalent to a constant temperature in the range between +3 and +5° F., or roughly 3 degrees above the mean temperature.

Moisture loss from bird to package. Moisture losses from the bird that were deposited as frost inside of the package were naturally quite small in the wax paper packages, which were too permeable to permit appreciable build-up of moisture.

Frost formation was also small in the aluminum foil packages, due probably to two conditions: the permeability of the lapping edges of the foil through its seams and the small temperature differentials between the skin surface and the tightly pressed, highly conductive foil.

With the polyethylene bags, however, which provided low moisture permeability and opportunity for temperature differentials to build up between skin and packaging film, there was marked frost formation in pockets between skin surface and film and in the body cavity. Frost formation increased with increase in temperature. It should be particularly noted that frost formation for the fluctuating temperature condition exceeded by far the frost formed at the highest constant temperature (+10° F.), which also was the upper limit of the fluctuation. In fact, the frost formation for the —10° F. to +10° F. fluctuation was about twice that for the approximate mean temperature of 0° F., indicating the marked tendency for the cycling temperature to "pump" water out of the birds. Considerably greater frost formation was also observed in 140° F. scalded turkeys than in 126° F. scalded turkeys held at the same temperature. Weight losses observed after 18 months, limited at this time to only one turkey per group, suggested that moisture losses for the various groups were increasing in a more or less linear fashion with time, with no tendency to plateau.

Relative changes in appearance of the frozen surface (see Figure 2) for the various temperature conditions were compared subjectively for each packaging condition, and were found to correspond for the most part to differences in moisture losses reported in Table 1. The extent of typical, white, dehydrated areas increased regularly with increase in storage temperature. Extent of visible dehydration for the fluctuating (—10 to +10° F.) temperature condition lay between the amounts found for the constant —10° F. and +10° F. conditions and, possibly because of bird-to-bird variation, could not be clearly distinguished from the dehydration at the constant 0° F. condition.

Comparison of the effects of packaging material, at each temperature, indicated as anticipated that polyethylene bags gave good protection for 12 or even 18 months with development of only a few pock marks (dehydrated areas about the feather follicles), while packaging in wax paper resulted in a severely dehydrated surface within six months. Lack of a complete seal along the lapping edges of the aluminum foil resulted in appreciable loss of moisture from foil-wrapped turkeys, with a corresponding deterioration in appearance intermediate between those found for polyethylene and wax paper. Turkeys scalded at 140° F. deteriorated more rapidly in appearance than those scalded at 126° F., whether packaged in polyethylene or aluminum foil.

Peroxide development in the raw depot fat of the various groups increased with increase in temperature as indicated in Table 2. Peroxide values for the fluctuating groups fell in all cases between the values for

TABLE 2

Peroxide development in depot fat of turkeys[1] as related to storage temperatures (12 months storage)

Packaging	Storage temperature	Peroxide values[2] of depot fat	
		in neck region	in visceral cavity
	° F.	*meq./kg.*	*meq./kg.*
Polyethylene			
	—30	1	2
	—10	1	5
	0	2	40
	+10	9	200
	—10 to +10	3	40
(140° F. scald)	0	1	40
Wax paper			
	—10	2	5
	0	3	60
	+10	7	100
	—10 to +10	5	40
Aluminum foil			
	0	2	40
(140° F. scald)	0	1	50

[1] All groups were scalded at 126° F. except the two designated as (140° F. scald).

[2] Mean values for 8 samples. Because of large variability between samples within any one group, values are reported only to one significant figure.

Figure 2. Appearance of turkeys after storage in wax paper for 12 months at temperatures, from left to right, of −10° F., 0° F., temperature fluctuating from −10 to +10 to −10° F. every 24 hours, and +10° F., respectively.

constant −10° F. and constant +10° F. storage temperatures and, in consideration of the large variability of values within groups, did not differ significantly from the values obtained for the constant 0° F. condition. Despite marked differences between packaging materials in permeability and moisture losses, there was surprisingly little difference in peroxide values at any one temperature due to type of package. Also, the 140° F. scalded groups did not differ from those scalded at 126° F. and stored at the same (0° F.) temperature. Fat in the skin and subcutaneous layers of the back were analyzed for peroxides and found in all groups to contain less than 2 meq./kg. Visceral fat, which is in a highly exposed position, was the only fat that developed peroxide values usually associated with objectionable organoleptic rancidity. Peroxide values found after 18 months were naturally larger but otherwise confirmed the differences between groups found after 12 months.

Flavor changes. Evaluation of the roasted carcasses by a trained taste panel (Table 3) revealed small but consistent increases in rancidity with increase in the constant storage temperature. Results of the organoleptic tests were for the most part consistent with the peroxide development described above. Values for the fluctuating (−10° F. to +10° F.) condition in most cases fell near the value for a constant 0° F. condition. Because of the great variability of the assigned ranks, indicated by lack of statistical significance for most differences, it is impossible to establish from the organoleptic evaluation what constant temperature is equivalent to the fluctuating condition. From a practical standpoint, however, it appears that the effect of the fluctuating temperature condition on rancidification does not differ in any important way from the effect of a constant temperature equal to the mean of the fluctuations. Values for pan drippings were not included in Table 3, because they did not show any consistent trends between temperatures. Organoleptic comparison between birds scalded at 126° F. and 140° F. and held in polyethylene and aluminum foil at 0° F. (groups 2, 5, 10, 11) disclosed no significant differences in rancidification due to scalding temperature or these packaging materials. This confirms earlier findings that

TABLE 3

Influence of temperature condition on rancidity development in turkeys stored for 12 months

Packaging	Storage temperature	Average rank[1] (1 = least rancid; 4 = most rancid)		
		Light meat	Dark meat	Skin
	°F.			
Wax paper	−10	2.1	2.3	1.8
	0	2.4 *	2.4	2.6 *
	+10	3.0	2.8	3.3 **
	−10 to +10	2.4	2.4	2.2 **
Polyethylene	−10	2.4	2.4	1.9
	0	2.2	2.5	2.6
	+10	2.9	2.7	2.8
	−10 to +10	2.4	2.4	2.7
Polyethylene	−30	2.0	2.1	1.7
	−10	2.1 *	2.4 *	2.1 ** **
	+10	3.1	2.9	3.7 **
	−10 to +10	2.8	2.5	2.5

[1] Values represent means of ranks assigned to roasted birds by six or seven judges. There were six replications of each tasting for the wax paper groups and four replications for all other groups. All statistically significant differences are indicated by an * (5% level) or ** (1% level of probability).

rancidification is independent of scalding temperature *(3)* and, more specifically, is independent of removal of outer skin layer.

The fluctuation of —10° F. to +10° F. to —10° F. every 24 hours is, of course, much larger and more frequent than would be expected in normal commercial operations. This fact gives greater weight to the conclusion that a fluctuating temperature in most respects is no more harmful than a constant temperature equal to the mean of the fluctuations. It must be emphasized, however, that this conclusion for the present should be considered valid only for the temperature range studied. In somewhat higher temperature ranges, where partial thawing and microbial growth become important factors, additional work is needed to establish the relative importance of temperature fluctuations. Studies with different commercial forms of poultry at higher temperature ranges are planned for the immediate future.

It is of interest that well-wrapped turkeys held at —10° F. for 12 months were, within experimental error, as good as those held at —30° F., thus confirming the view that there is little, if any, practical advantage gained in storage below —10° F.

SUMMARY

Quality deterioration in ready-to-cook Broad Breasted Bronze turkeys was studied over a period of 18 months as a function of temperature, temperature fluctuation, packaging, and scalding temperature. Experimental temperature conditions included constant temperatures of —30° F., —10° F., 0° F., and +10° F., and a temperature that fluctuated from —10° to +10° to —10° F. in a 24-hour sine wave cycle.

Moisture loss from a relatively permeable package increased in expected fashion with increase in temperature, while loss for the fluctuating-temperature condition exceeded that for the corresponding mean temperature (0° F.) and by rough interpolation equaled the loss for about a constant +3° F. condition. In relatively impermeable packages, appreciable amounts of moisture were lost by the bird and deposited as frost inside of the package. Frost formation increased with temperature, and for the —10 to +10° F. fluctuation was considerably greater than for the highest (+10° F.) constant temperature. Turkeys scalded at 140° F. developed almost twice as much frost as birds scalded at 126° F.

Deterioration in appearance associated with the dehydration of the skin layer, while principally influenced by the relative permeability of the package, increased appreciably with each stepwise increase in storage temperature. Appearance of the turkeys held at the —10° F. to +10° F. fluctuation did not differ significantly from that of birds held at 0° F. Similarly, rancidity development in the raw fat, and accompanying off flavors in the cooked fat and meat, were about the same for the fluctuating temperature condition as they were for the mean (0° F.) temperature.

The results indicate that, under normal commercial conditions of frozen storage (moisture impermeable package and temperature range of —10° F. to +10° F.), the only factor for which a periodic temperature fluctuation is inferior to the mean temperature is the accumulation of frost in the package, and this influences appearance but not eating quality.

Acknowledgments

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Development of a New Concept for Processing Fruit Jelly[a]

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A manufacturing procedure which would result in higher product quality and processing time economy is reported. The basic concept of this new method involved a processing procedure in which a portion of the fruit juice was not subjected to boiling temperatures. The fruit juice for a given batch was divided into two or three portions, only one of which was boiled to evaporate the required amount of water. The sugar and pectin were dissolved in another portion at a relatively low temperature. This and a fresh juice portion, when used, were combined with the concentrated portion and the mix was heated to the prescribed filling temperature. This innovation was expected to minimize loss of volatile flavors, reduction of jelling power and formation of brown reaction products. A statistical design known as a "Balanced Incomplete Randomized Block Arrangement" was used for this research. The experimental process treatments produced an apple jelly which was definitely superior in quality to that produced by the simulated commercial process control.

Commercial apple jellies have been manufactured using either the atmospheric or the vacuum method for evaporation of water. Atmospheric concentration results in loss of volatile flavor constituents, development of brown reaction products, and heated or scorched flavors. Vacuum evaporation at relatively low temperatures practically eliminates the browning reaction and heated flavor. However, at the reduced pressures the highly volatile flavoring components which are such essential constituents of fresh apple flavor are vaporized. Therefore, the resulting jelly product is lacking in typical flavor.

A few manufacturers have installed fractionating columns for stripping the volatile flavoring components or essences from the product vapors of the vacuum evaporators. These essences are concentrated by additional fractionation, and the volatile materials are returned to the finished jelly just before the product is poured into jars. Jelly concentrated at low temperatures and prepared with essence is characterized by an excellent fresh apple flavor. Apple jellies processed in this manner are of high quality and excellent acceptability but may be expensive.

It has been shown that heat has two deleterious effects upon the jellying characteristics of pectin. Hinton *(3)* attributed the loss of jellying power caused by heating to rupture of the molecular chains by simple hydrolysis. Olson *(8)* found that a weaker jelly resulted when a solution of pectin and sugar was heated at 100° C. (212° F.) than when it was heated at 70° C. (158° F.) or less. He stated that this was due to differences in the network of pectin fibrils produced by the higher processing temperature, rather than to actual degradation of the pectin molecule.

Although the presence of some invert sugar in a jelly is desirable, prolonged heating at high temperatures will result in excessive sucrose inversion with subsquent crystallization of dextrose upon cooling *(7)*. The other product of inversion, levulose, has been shown by Meschter *(5)* to be much more active than sucrose in degrading anthocyanin pigment.

The objective of this research was to advance and evaluate a jelly manufacturing procedure in which the undesirable effects of heating would be decreased. This was accomplished by subjecting only a portion of the juice to boiling temperatures.

EXPERIMENTAL

The basic concept was applied by dividing the fruit juice to be used in the jelly manufacture into *2* or *3* portions. One portion was taken for dissolving the sugar and pectin and its temperature was not allowed to rise above 180° F. A second portion was heated to evaporate the requisite amount of water. Here the atmospheric boiling point of the concentrated juice was the highest temperature reached. A third portion, when used, received no heat treatment until it was combined with the other portions. The total jelly batch was brought to 180° F. before filling the jars.

Experimental design. The experimental design chosen is known as the "Balanced Incomplete Randomized Block Arrangement." It was considered that the tasting of 5 samples of jelly at each judging period would not be unduly fatiguing to the judge. Within this limitation, the amount of raw material and the availability of 6 judges, the most suitable arrangement *(1)* required 25 treatments with 5 treatments per block and 30 blocks.

The factors considered in selecting the 25 process treatments were relative amounts of juice to be used for solution and evaporation, type of sugar system and need for comparison with simulated commercial treatments. Sugar solubility tables *(9)* indicated that about 33% of the juice was required to dissolve the added sugar and pectin readily. Calculation showed that only 13% of the total juice weight had to be evaporated in order to meet legal requirements. This amount of water could be removed from one-third the total juice without allowing the soluble solids content of the concentrated juice to rise above 25%. This may be compared to commercial practice where the final boiling of the jelly batch is done at 65% soluble solids. Therefore, the conventional processing temperature is higher and its rate of heat transfer is probably lower. The two sugar systems investigated for use as raw material were sucrose plus dextrose and sucrose plus dried corn syrup solids.

Selection of the levels used for the individual treatments is illustrated in Figure 1, which shows portion of juice to be used for solution plotted against the portion to be used for concentration. The limiting conditions described above were made the apices of an isosceles triangle which circumscribed the area under investigation in this experiment. Midpoints of the sides of the triangle were chosen as intermediate conditions. In the cases

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where the sum of the 2 portions totaled less than unity, the difference was made up with a fresh juice portion. The 3 apices and the midpoint of the base of the triangle were arbitrarily chosen for duplication. With the other 2 midpoints, this gave a total of 10 conditions. This same series of conditions was used for each of the 2 sugar systems, giving a total of 20 experimental processing treatments. The remaining 5 treatments were

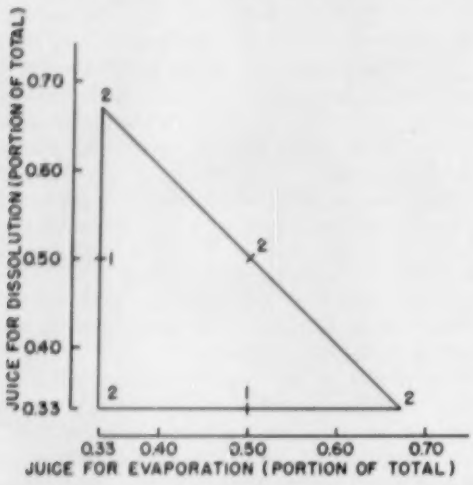

Figure 1. Diagram showing method used in selecting treatment conditions.

assigned to simulated commercial treatment conditions using the same equipment.

Equipment. The batch size of each run was limited to one gallon of apple juice, so small steam-jacketed stainless steel kettles were fabricated for this purpose. During cooking, the kettle was placed on a heavy duty solution balance so that the concentration operation could be taken to a previously calculated weight.

Raw materials. According to the Federal Standard of Identity a pure fruit jelly is prepared from a mixture of not less than 45 parts by weight of standard fruit juice to each 55 parts by weight of sugar and must be concentrated by heating to a soluble solids content of not less than 65%. Pectin and fruit acid may be added to insure a good jelly formation. The following formula was used for each of the 10 treatments designated under sucrose-dextrose sugar system and for each of the 5 runs processed by the simulated conventional method:

Apple juice (13.7° Brix)	8.76 lbs.
Sucrose	7.68 lbs.
Dextrose (2.95 lbs. dry + 0.24 lb. H_2O)	3.19 lbs.
Pectin, 150 grade, slow set	0.10 lb.
Standard Citric Acid Solution (4 lbs. dry acid + water to one gal.)	0.05 lb.

In the remaining 10 treatments the dextrose in this formula was replaced by 3.03 lbs. dried corn syrup solids (containing 0.08 lb. water). Both the dextrose, bearing the brand name Clintose,* and the corn syrup solids were supplied by Clinton Foods, Inc., Clinton, Iowa.

The apple juice used in this experiment was pressed from Winesap and Jonathan apples. The juice was allowed to settle overnight. The supernatant liquid was filtered and pasteurized at 170° F. for 30 seconds in a plate heat exchanger. After collecting in 3-gallon containers, it was placed in storage at —40° F. The juice was defrosted just prior to processing and standardized at 13.7° Brix by the addition of tap water.

Procedures. In the experimental processing runs the standardized juice was weighed into portions as shown in Figure 1. The portion taken for concentration was added to the small kettle and steam at 15 p.s.i.g. was admitted to the jacket. After concentration was completed, the portion of juice taken for sugar solution was added to the larger kettle and heated with 15 p.s.i.g. steam pressure to 175° F. A mixture of pectin with some of the sucrose was then dissolved followed by the addition and solution of the remaining sugars.

The fresh juice portion was held at room temperature during these operations. The 3 portions were then blended in the larger kettle and heated to 180° F.

In the case of the 5 simulated commercial runs all the juice was added directly to the larger kettle which was mounted on the balance and heated with 15 p.s.i.g. jacket pressure. The juice temperature was raised to 175° F. and the pectin and sugars were dissolved. When all ingredients except the acid had been combined, the batch was brought to a boil and concentrated to a precalculated weight.

The finished jelly was allowed to stand for several minutes and the surface foam was skimmed off. It was then poured into 4-ounce jars which contained 0.5 cc. standard citric acid solution. After standing overnight in covered jars, the jellies were covered with about ¼ in. of paraffin wax.

The processing runs were performed in a random order. The finished samples were allowed to stand at room temperature for one week in order to permit the jelly formation to reach equilibrium.

The jelly was organoleptically evaluated for flavor, color, jelly character, and lack of off flavor. Each organoleptic factor was judged independently and scored on a numerical rating scale with 9 for *excellent* and 1 for *extremely poor*. The objective tests included measurements of soluble solids content, pH, color, and jelly strength.

The rating for flavor indicated the quality and quantity of the apple flavor as well as the sugar-acid balance. Color was rated on the premise that a lighter color was more desirable. Color was down graded for the presence of a cloudy suspension. Jelly character rating was based on the firmness of the jelly. It was down graded if the jelly was too weak, too stiff, or if syneresis had occurred. Lastly, the jelly was rated for the absence of burnt, caramelized, scorched, musty, and other undesirable flavors. The organoleptic evaluation schedule used allowed each judge to be independent from the other judges and to taste a block of 5 samples at his convenience.

The soluble solids content of the jelly was determined with an Abbe refractometer having a direct reading sugar scale. The pH was read on a Beckman Laboratory Model pH Meter. The objective color measurement was made with the Hunter Color and Color-Difference Meter *(2)* using the U. S. Bureau of Standards white color standard reference plate. Measurements were made by reflectance upon a standard sample size. The jelly strength was determined by use of the Bloom Gelometer *(6)*. These objective tests were performed in duplicate on each sample. The average of the two results was used in the statistical analysis and subsequent evaluation of the treatments.

The remaining samples for each treatment or run were subdivided into four lots which were stored at 32°, 40°, 70°, and 100° F., respectively. These were removed after 2 months' storage time and allowed to come to room temperature. They were then examined both organoleptically and objectively using the same test procedures as those used on the initial samples.

RESULTS AND DISCUSSION

The data were subjected to statistical analyses of variance and covariance. These analyses yield appropriate tests of significance of differences caused by different processing treatments when several variables are included in the experimental design.

The pH of the products from the various treatments was generally about 3.25. Differences in these pH read-

* Mention of brand names in this journal does not imply indorsement of the product over similar products on the commercial market.

TABLE 1
Analyses of variance and covariance
Initial organoleptic evaluation

Variance				Covariance			
Variance associated with	Degree of freedom	Mean square	Variance ratio	Variance adjusted for	Degree of freedom	Adjusted variance	Variance ratio
Flavor							
Treatment	24	8.58	17.1				
Error	96	0.50					
Color							
Treatment	24	6.32	27.4				
Error	96	0.23					
Gel Character							
Treatment	24	8.01	13.6	Flavor			
Error	96	0.59			24	1.66	2.96
Lack of Off-Flavor					95	0.57	
Treatment	24	9.12	12.9	Flavor			
Error	96	0.71			24	0.72	1.32
					95	0.55	

ings and in the results of the objective color measurements did not appear to be of any practical importance and were omitted from the statistical analysis. A correlation of 0.76 was found between the Bloom Gelometer measurement for jelly strength and the organoleptic jelly character rating. Also, there was a correlation of 0.65 between the Bloom Gelometer measurement and the soluble solids content as measured on the Abbe refractometer. Both of these correlations were significant at the 1% confidence level.

Analyses of variance and covariance of the initial organoleptic data are presented in Table 1. The data for each organoleptic characteristic showed highly significant differences between treatments, the variance ratio in each case exceeding the 1% level. Since in this experiment we have 24 degrees of freedom for the numerator and 96 degrees of freedom for the denominator, the variance ratio must be larger than 1.95 to be significant at the 5% level and larger than 2.56 for significance at the 1% level. Thus, a variance ratio of 2.57 shows chances are better than one in a hundred that the difference in results obtained between the two treatments or variables being compared is real and not due to experimental errors. When the evaluations for jelly character and lack of off flavor were adjusted for the flavor evaluation, the differences were much reduced, and lack of off flavor was no longer significant. Therefore, we considered the organoleptic ratings for flavor and color fairly adequate for evaluating treatment effects, and the ratings for jelly character and lack of off flavor were not studied further. These findings were also true for each sorage condiion.

Analyses of variance for the flavor and color ratings representing each storage condition are shown in Table 2. The organoleptic flavor and color values of the jelly products after storage at various temperatures showed highly significant differences between treatments. These differences were only slightly correlated with the corresponding initial differences. The differences in treatment variation ratings were not significantly affected by storage at the higher temperatures. Product storage for periods longer than two months would probably show significant differences due to storage temperature.

Organoleptic averages, differences between averages, and the corresponding least significant differences between groups of treatments, appear in Table 3. These scores have already been corrected for differences arising from experimental error, according to methods given by Kempthorne *(4)*, so that the differences shown are due entirely to the effects of the variables being compared. It should be noted that the amount of difference required for significance is small as compared to the 9-point total range of the rating scale. Pronounced

TABLE 2
Analyses of variance
Storage product evaluation

Variance			
Variance associated with	Degrees of freedom	Mean square	Variance ratio
32° F. Storage			
Flavor			
Treatment	24	8.62	13.9
Error	96	0.62	
Color			
Treatment	24	6.49	24.0
Error	96	0.27	
40° F. Storage			
Flavor			
Treatment	24	7.98	12.4
Error	96	0.64	
Color			
Treatment	24	6.71	27.9
Error	96	0.24	
70° F. Storage			
Flavor			
Treatment	24	9.53	18.7
Error	96	0.51	
Color			
Treatment	24	6.92	21.6
Error	96	0.32	
100° F. Storage			
Flavor			
Treatment	24	5.46	14.0
Error	96	0.39	
Color			
Treatment	24	6.04	33.6
Error	96	0.18	

quality differences were found between the experimental treatments embodying the basic concept of this research and the simulated commercial treatments (Table 3). The experimental treatments were rated very good (about 8.7) but the simulated commercial treatments rated only a little above fair (about 6.7).

Comparison of the two sugar systems showed there was no difference in flavor initially. However, after storage the sucrose-dextrose sugar system resulted in significantly superior flavor. This sugar system rated significantly better in color at each evaluation with one exception. Perhaps these color differences can be ex-

TABLE 3

Mean organoleptic scores corrected for taster and storage time differences, mean score differences between groups of treatments, and the differences required for significance at the one percent level

Evaluation	Flavor				Color			
	Mean score		Difference		Mean score		Difference	
	for (x)	for (y)	found	required	for (x)	for (y)	found	required
Experimental Treatments (x) vs. Simulated Commercial Treatments (y)								
Initial	8.84	6.32	2.52	0.26	8.76	6.61	2.15	0.18
32° F.	8.86	6.25	2.61	0.29	8.67	7.18	1.49	0.19
40° F.	8.71	6.82	1.89	0.29	8.71	6.82	1.89	0.17
70° F.	8.73	6.76	1.97	0.25	8.89	6.01	2.88	0.20
100° F.	8.74	6.71	2.03	0.33	8.74	6.72	2.02	0.16
Sucrose-dextrose Sugar System (x) vs. Sucrose-corn Syrup Solids Sugar System (y)								
Initial	8.82	8.85	0.03	0.23	8.90	8.63	0.27	0.16
32° F.	9.01	8.70	0.31	0.26	8.77	8.56	0.21	0.17
40° F.	8.88	8.55	0.33	0.26	8.77	8.66	0.11	0.16
70° F.	8.82	8.64	0.18	0.23	9.04	8.74	0.30	0.18
100° F.	8.86	8.62	0.24	0.21	8.99	8.49	0.50	0.14
Experimental Treatments Without Fresh Juice Portion (x) vs. Treatments With Fresh Juice Portion (y), Considering the Sucrose-dextrose Sugar System Only								
Initial	8.79	8.91	0.12	0.34	8.82	8.68	0.14	0.23
32° F.	8.84	8.88	0.04	0.38	8.72	8.59	0.13	0.23
40° F.	8.74	8.68	0.06	0.33	8.80	8.59	0.21	0.26
70° F.	8.67	8.84	0.17	0.30	8.92	8.84	0.08	0.20
100° F.	8.66	8.86	0.20	0.38	8.80	8.64	0.16	0.24

plained by the fact that solution of the sucrose-corn syrup solids system required considerably more time at elevated temperatures.

Use of a fresh juice portion gave a higher mean flavor score although the difference was not great enough to be significant. However, it had an adverse effect upon the mean color score, but the difference was of low magnitude and did not reach the one percent level of significance. This difference in color may be due to the clarification which resulted when the juice was heated for somewhat longer periods. If this is true, the use of a clarified juice as the raw material might increase the advantage of a fresh juice portion. Differences in quality between the various individual experimental treatments within a given sugar system (see Figure 1) were not significant.

Under the conditions of this experiment, processing time economies were realized for the experimental processing concept. A small saving in pectin costs should be realized by the use of this new method because a smaller proportion would be degraded during the shorter cooking time and at the lower temperature of heating.

CONCLUSIONS

The experimental process treatments involving the basic concept of this research produced an apple jelly which was definitely superior in quality to that produced by a simulated commercial process.

Under the conditions of this experiment, the use of a sucrose-dextrose sugar system resulted in a jelly of significantly better quality than did the use of a sucrose-corn syrup solids system.

Acknowledgment

This experiment was designed and the resulting data were statistically analyzed under direction of Dr. Horace W. Norton, Professor of Agricultural Statistics, University of Illinois, Urbana.

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The Use of Fresh Fruit Objective Tests to Predict the Quality of Canned Italian Prunes[a,b]

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In a study of several objective tests on raw prunes, such as soluble solids, acid ratio, pressure test, and percent solids, good correlation (r = .90 or higher) was shown with the flavor of canned prunes. Data from one season's study point to the pressure test as the most precise method for maturity differences in fruit harvested every three days.

Although not a crop of national importance, Italian Prunes or Purple Plums are regionally important in the Pacific Northwest. Their production and processing have not kept pace with the national economy *(6)*. The reason may be related to the quality and marketing of the processed prune. Quality factors therefore should be examined critically, which we have done in these and succeeding experiments. The 1954 establishment of the Purple Plum Association to improve the quality and promote the marketing of Italian Prunes is an industry reaction to the present situation.

In the Pacific Northwest, the Italian Prune destined for the cannery is generally harvested in the fall before the start of the rainy season. Climatic conditions and cultural practices during the growing season cause great variation in the maturity of the fruit at harvesting, on a year to year basis. In some years fruit may be harvested while relatively green while in others shriveling may have taken place around the stem end. There appears to be no standard method of discerning the best harvest date. Ordinarily because of economics trees are harvested only once with a vigorous shaking which removes all but the greenest fruit. Fruit are picked up and shipped to the processor.

Fresh fruit maturity factors such as percent soluble solids, titratable acidity, soluble solids-acid ratio, pressure test and subjective color have been used by Gerhardt and English *(3)*, Tucker and Verner *(5)*, and by Fisher *(1)* to judge approximately the earliest time to harvest Italian Prunes destined for the *fresh* market. Hartman *(4)* has made a descriptive study of the relationship between maturity and canned fruit quality. There have been no statistical correlations of fresh fruit quality indices and canned fruit quality.

The statistical study was undertaken to determine which of a series of maturity indices of Italian prunes could best be used for predicting the *canned* fruit quality, their approximate values, and which maturity indices are useful as harvesting guides. Flavor panel scores were used as the single measure of canned fruit quality. Although not proved by comprehensive consumer surveys, flavor is suspected of being highly valued by consumers and the canned Italian prune (Purple Plum) does have a distinctive, aromatic quality not found in other varieties.

MATERIALS AND METHODS

Fruit was grown and harvested on the Horticulture Farm of Oregon State College during the 1951 growing season. Two hundred fruits were separately harvested from each of five non-irrigated Italian Prune trees every third day for a total of 9 harvests. Fruits were definitely greenish in color at the start and overripe at the finish of harvesting. Sampling was by limb or part of a limb, harvesting every fruit except the obviously rotten or withered. This sampling procedure was an attempt to simulate commercial harvesting where all fruits except the very immature are shaken from the tree in one harvesting.

Fresh fruit studies. Fruit from each tree were treated as a replication. The 200 harvested fruits from each tree were washed and 40 fruits were drawn at random for the series of fresh fruit quality tests. Weight was recorded. The fruits were visually graded by the authors according to outer skin appearance into acceptable blue-purple and non-acceptable greenish groups. Each fruit was subjected to two punctures by the 5/16th inch Ballauf (U. S.) pressure tester to determine ripeness. Color of the flesh of each ten pitted, peeled prunes (four groups for each sampling) was recorded using the Hunter Color Difference Meter *(2)*. N. B. S. Maize standard with the assigned values Rd 54.0, a-10, b-32 was used.

Eighty grams of peeled and pitted fruit were placed in a Succulometer cup and subjected to 500 pounds pressure to extract a fairly clear prune juice. Percent soluble solids (principally sugars) were determined using an 0-60 Bausch and Lomb refractometer. The remaining fruit product was blended into a uniform pulp for pH determinations. A 100 g. aliquot of this pulp was titrated against standardized NaOH to determine titratable acidity in terms of malic acid. Soluble solids-titratable acidity ratio was calculated.

Fruits of each tree on each harvest date after having been subjected to the series of quality measurements were again chosen at random and placed in cans for processing.

Processing techniques. Eleven ±.5 ounces of whole unpitted prunes were placed in No. 2 fruit enamel cans. To each can was added 180° F., 30° Brix syrup allowing one-half inch head space. The cans were exhausted for 4 minutes at 180° F. The cans were immediately closed and processed for 12 minutes at 212° F.

"Standard" sample. About midway through the harvesting season, fruit from two prune trees was harvested and processed according to the above procedures. This lot of canned prunes was used as standard reference in all subjective flavor and color evaluations.

Canned fruit studies. Objective quality measurements carried out on the *canned* fruit were as follows: cut-out syrup Brix, percent transmittance of canned juice, color of the skin (Hunter Rd and b values), pH, titratable acidity and cut-out syrup Brix-titratable acidity ratio. The use of these measurements to determine quickly canned fruit grade and their relationship to subjective flavor and color scores is evaluated in another paper *(7)*.

For both the *raw* and *canned* product study the entire group of canned fruit samples was evaluated by a series of "taste" panels for flavor score. The multiple comparison method using a marked "standard" was used throughout the testing. The

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[a] Technical paper no. 910, Oregon Agricultural Experiment Station. Contribution of the Department of Food Technology.

[b] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, July 1, 1954.

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average panel size was 8 individuals drawn from the same 14 judges throughout the study. Each judge when possible evaluated the flavor of each series of canned prunes four different and unrelated times for each harvest of each tree. Thus if a judge had been present for each panel, he would have evaluated experimental samples for flavor 180 times at 45 sittings.

Before starting the organoleptic examinations the so-called "Standard" sample of canned prunes was graded by a group comprised of professional graders from the Agricultural Marketing Service and several industry representatives. They graded this "Standard" sample as 7 in flavor out of a possible score of 10. During the entire flavor evaluation work this marked "Standard" was supplied at each panel meeting. The judges were asked to compare the unknown experimental samples with the "Standard." Judges were previously tested on prunes and only those who were in agreement, i.e., within 3 sigma limits of the group, were selected to make up the panel of 14. Fresh fruit quality factors were correlated with the flavor of the canned fruit. Analysis of variance was used to determine if there were physical and chemical differences between fruit harvested every 3 days.

RESULTS AND DISCUSSION

Since this paper entails only the relationship between fresh fruit quality factors and canned fruit flavor quality, there will be no attempt to include here results from other tests conducted on the canned fruit *(7)*.

To get a concise picture of the results, refer to Table 1 which shows the relationship between fresh fruit quality factors and canned fruit flavor.

TABLE 1
Correlations between fresh fruit quality factors and flavor of the canned prunes

Quality tests	r*	$s_{y.x}$, in flavor units Scale of 1 to 10
1. Soluble solids-acid ratio	+.92	.33
2. % soluble solids	+.90	.37
3. Pressure test	−.91	.33
4. Color: Hunter "a"	+.81	.36
5. Titratable acidity	−.86	.44
6. Acceptable fruit	+.77	—
7. pH	+.68	—
8. Weight of fruit	+.54	—

* N = 40.

As can be seen from Table 1, soluble-solids acid ratio, pressure test, and percent soluble solids show correlation coefficients of 0.9 or better with flavor and have suitably low $s_{y.x}$ (standard error of estimate values). These 3 methods appear best from the standpoint of predicting canned fruit flavor quality.

Coupled with the predictability of canned fruit flavor or quality, the farmer and processor are interested in knowing just how precise the tests are in showing differences among raw fruit harvested every few days (in this study, every three days). These data are collected in Table 2.

Soluble solids-acid ratio. The mean soluble solids-acid ratio ranged from a low of 11.3 for the first harvest date to 24.2 in fruit of the last harvest date. The increase in the ratio was rather consistent from the first to last harvest date.

From Table 2, column 2, it is seen that this test showed good 3-day harvest precision in most cases. However, the use of this method would probably be limited to a processor's laboratory as the farmer would be unable to determine the percent soluble solid and titratable acidity necessary to calculate this ratio. A raw fruit soluble solids-acid ratio of 21.5 (harvest No. 8) produced a canned fruit with the most desirable flavor.

The correlation coefficient between canned fruit flavor and soluble solids-acid ratio was highest for any

TABLE 2
Statistical evaluation of quality tests with respect to harvest dates

Harvest[3]	Harvest means					
	Sol. solids acid ratio	Pressure test	Percent sol. solids	Flesh color, Hunter "a" + 10	Flavor scores	% Malic acid
1	11.3	10.6	11.7	+5.15	4.5	1.04
2	12.6	9.5	12.3	+6.39	5.4	0.97
3	14.5	8.9	12.8	+8.46	5.5	0.89
4	16.5	7.8	13.9	+10.48	6.0	0.84
5	18.1	6.5	14.9	+12.99	6.4	0.83
6	19.5	6.2	15.7	+13.93	6.6	0.81
7	20.2	5.3	15.8	+14.61	6.8	0.78
8	21.5	4.7	16.3	+15.12	6.9	0.76
9	24.2	3.8	16.5	+16.03	6.8	0.68
LSD[1]	1.41	0.51	0.98	1.66	0.37	0.15
F.	74.68**	178.4**	29.14**	48.20**	41.45**	4.64**

** Highly significant with respect to harvest dates.
[1] LSD at 5% level.
[3] Harvest intervals were three days in all cases.

fresh fruit test. As shown in Figure 1, the high correlation coefficient of +.92 and a relatively low standard error of estimate, .33, show that canned fruit flavor was validly and accurately predicted from the soluble solids-acid ratio of the raw fruit. At the last harvest date, the raw fruit decreased in acidity and increased slightly in sugar, reflected in the soluble solids-acid ratio (24.2) and the product became less desirable in flavor. There appears to be a definite point where there is a good

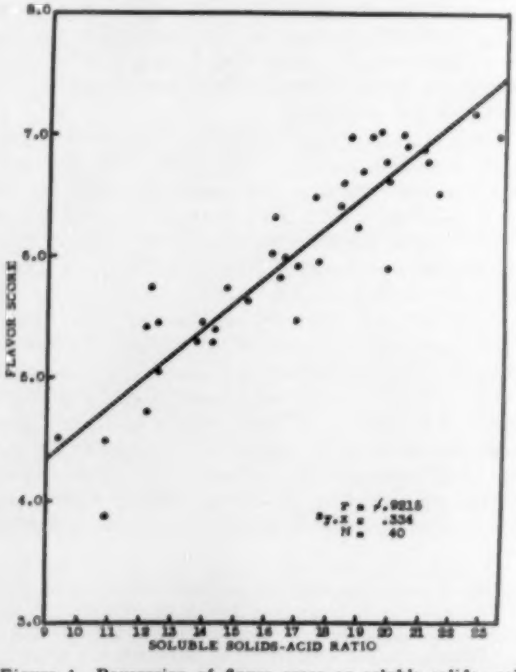

Figure 1. Regression of flavor score on soluble solids - acid ratio of fresh fruit.

balance between acidity and sweetness, so that at this point, flavor is most highly acceptable.

Pressure test. Pressure test readings show a continual and steady decline throughout the harvest season. It may be seen that there was a significant difference in firmness of fruit harvested every 3 days except between harvest dates 5 and 6. This indicates that under the conditions of this study the pressure tester is an excellent objective instrument to show maturity differences among prunes harvested every three days. Both the farmer and processor would find this method of checking prune maturity precise and fast. In this study a mean pressure test reading of 4.7 with the $\frac{5}{16}$-inch plunger gave canned fruit with the best flavor.

The correlation between pressure test readings (firmness of the raw fruit) and flavor of the canned fruit is rather high. The correlation coefficient is —.91 which indicates the use of a pressure tester to estimate canned fruit flavor quality is quite appropriate. From the regression line in Figure 2 it can be seen that the lower end of the pressure test scale will give the best canned fruit flavor. Pressure test readings lower than 4.7 indicate that the fruit has passed its optimum flavor range and is definitely too ripe for good canned fruit quality. This effect is shown up in the canned fruit flavor scores of the

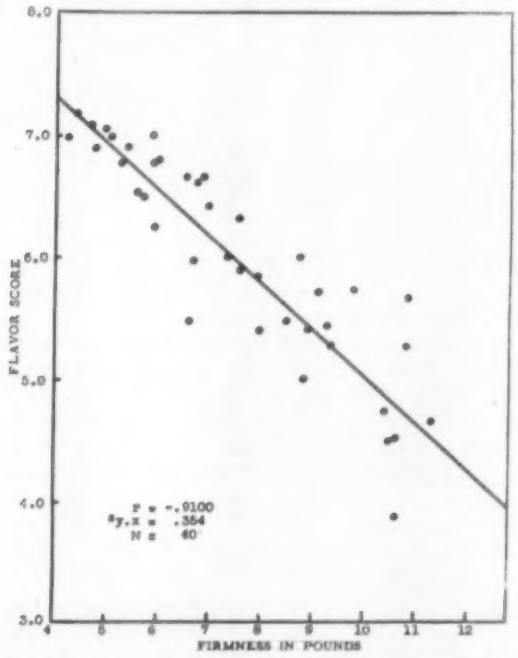

Figure 2. Regression of flavor score on pressure readings ($\frac{5}{16}$-inch plunger) of fresh fruit.

9th harvest date. This method appears to be a quick and easy way to judge harvesting date and predict the flavor quality of the canned fruit.

Percent soluble solids. The percent soluble solids in this particular orchard did not show great changes. The range was from 11.7 to 16.5. Even in the very ripest fruit which had shrunken slightly there was no soluble solids reading above 17.5%.

Results in Table 2, column 4, show that harvest dates 6, 7, 8 and 9 are not significantly different in percent soluble solids. The greatest difference in solids appears early in the harvesting season. The 3-day harvesting precision of this test is not satisfactory; therefore it would not be used as a harvest guide unless calculation of the soluble solids-acid ratio was desired. A mean soluble solids reading of 16.3 gave canned fruit with the highest flavor score.

The relationship between percent soluble solids and canned fruit flavor is high ($r = +.90$). The low standard error of estimate (.37 flavor units) and relatively high correlation indicate that percent soluble solids may be precisely and validly used to predict canned fruit flavor quality. The regression line in Figure 3 shows

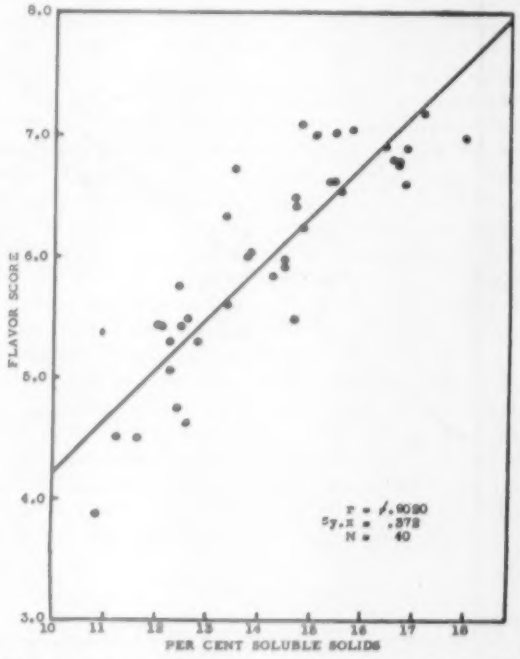

Figure 3. Regression of flavor score on percent soluble solids of fresh fruit.

the usability of this method. As the fruit move past the optimum soluble solids reading of 16.3 the flavor acceptability appears to decrease.

Color of flesh (Hunter "a" readings). Exterior color of the prune has been shown to be inferior to interior color as an index of maturity, especially by Gerhardt and English *(3)*. On the prune flesh, two of the Hunter reflection meter *(2)* scales showed ranges too small to be useful. They are Rd (reflectance) and "b" (blue to yellow). Therefore the "a" scale alone (green to red) was used, with 10 added to make all readings positive.

The results in Table 2 bear out quantitatively what is found in practice subjectively, viz. that color of the flesh can be used to some extent as a harvest criterion, especially for minimum quality. The unmodified readings range from —4.9, greenish, to 6.0, yellowish, for the last harvest date. Under the conditions of the ex-

periment, color readings of harvest dates 1 and 2 were not significantly different. The fruit was definitely unripe. Fruit of harvest dates 2, 3, and 4 were significantly different in color. The fruit of harvest dates 5, 6, and 7 fell within the same color group. The fruit of harvest dates 8 and 9 fell within another color group. Thus, after harvest date 5, approximately a nine day period was required to detect significant differences in the flesh color by means of Hunter readings. The correlation coefficient of +.81 as shown in Figure 4 is quite satisfactory, in general, and although it is lower than that of titratable acidity for prediction of flavor, the error of estimate is less.

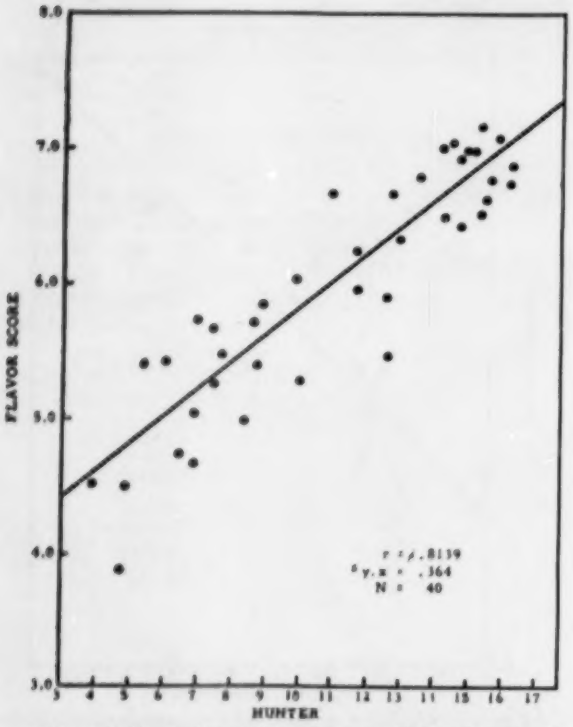

Figure 4. Regression of flavor score on Hunter "a" plus 10 readings of fresh fruit flesh color.

Canned fruit flavor. The organoleptic flavor determinations of the canned prune showed a definite increasing trend in flavor acceptability from harvest date 1 to 8 with the 8th harvest date exhibiting the highest numerical score of 6.9. The flavor of the prunes on harvest date 8 was described by tasters as having an excellent sugar-acid balance with the tangy ripe prune flavor. Harvest date 9 had a flavor score of 6.8 which is not significantly different from the 8th date but members of the panel in their comments, which are hard to evaluate, indicated fruit from the majority of trees on the 9th harvest date had an overripe or musk flavor and were moving past their peak in flavor acceptability. Organoleptic data on fruit color also show a similar reduction in fruit acceptability on the 9th harvest date. With reference to column 6, Table 2 it can be seen that the range of flavor acceptability scores is relatively narrow. This may be explained by the fact that prunes harvested early, although they approached green gage plums in appearance, were found not to be sub-standard in flavor acceptability. Some judges found acidity a desirable characteristic of the fruit and graded higher those tart samples and had a tendency to down grade the riper samples. Judges' scores indicate that they were much less responsive to physical and chemical changes in the fruit than were certain maturity indices used in the experiment.

The significant flavor differences in fruit are most prevalent in the early part of the harvesting season. Fruit harvested every other harvest date is generally found to be different in flavor; in other words, fruit harvested every 6 days would have significantly different canned fruit flavor. The scores of fruit harvested later were close together in flavor acceptability.

The correlation between visual color panel scores and flavor scores of canned prunes was high ($r = +.95$). The standard error of estimate was .27 flavor score units.

SUMMARY

The results of this study pooled with studies of fruit harvested in several more seasons could be used to set up objective tests of canned fruit quality. Perhaps the use of two or more quality tests should be developed to predict more accurately the final canned fruit quality. This one season's study indicates the pressure tests to be the most precise method of showing maturity differences in fruit harvested every three days. Soluble solids-acid ratios of the raw fruit also possess good three-day precision as a guide to harvest maturity. Color of flesh is fairly discriminating for three-day intervals but soluble solids appears suitable only for longer harvesting intervals. The nine-by-five factorial analysis of variance of means showed no significant differences between the 5 trees, except in one instance but showed highly significant differences between harvests.

It is shown that several objective tests on raw prunes, such as soluble solids-acid ratio, pressure test, and percent soluble solids, in the order named, show correlation coefficients of 0.90 or higher, with the flavor of canned prunes. Flesh color of raw fruit also has good precision in predicting the flavor of the canned product.

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Comparative Sensitivity of Rating Scale and Paired Comparison Methods for Measuring Consumer Preference[a,b]

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The scale rating and paired preference methods were compared for relative sensitivity in determining differences in consumer preference. The subjects were untrained observers and the conditions were limited to those under which the paired comparison method can be used. The rating scale and paired preference methods were shown to be equally sensitive whether the difference in preference was small or large.

The several available methods for obtaining quantitative judgments concerning some specified characteristic or object have been discussed extensively in the psychological literature *(2, 5)*, along with their merits and disadvantages. The three basic methods are paired comparisons, ranking, and rating; the latter is also variously called the method of single stimulus or absolute judgment, depending on its use. Each of the methods, with some modifications, can be applied to two conditions; psychophysics in which the physical continuum can be specified quantitatively and related to the psychological continuum, and psychometrics in which the psychological continuum has either no physical correlate, or has one that is only definable operationally. The psychometric techniques are of two types: one utilizes the names of things as stimuli; the other uses actual objects as stimuli. It is the latter type which is used for laboratory evaluation of foods. The former is useful for determining relative preference for different kinds of items, but rarely for establishing preference for different formulations of the same product. However, for either type of test, one of the three basic methods must be used.

Although most tests of foods have been conducted with some form of rating scale as a matter of convenience or economy, there seems to be a tacit assumption that the paired comparison method, though admittedly more tedious and unwieldy, is more elegant and precise. Harvey *(6)* has stated that the single stimulus method is scorned as unscientific but has asked why it has not been compared to paired comparisons, pointing out that we make many daily choices of foods and flavors against some memory standard, and do not ordinarily compare two products side by side.

The published reports show that the question of the comparability of single stimulus and paired comparison methods had been raised numerous times and solved in other areas, but not in that of food preferences. Psychophysical studies have shown that a single stimulus method yields discriminations about as fine and precise as the method of constant stimuli, which involves presentation of pairs of samples. This is exemplified by work on the difference limen for salt *(10)* and on the judgment of lifted weights *(12)*. Psychometric studies of value judgments have also yielded data to support the hypothesis that the two methods are comparable. It was shown *(8)* that experienced judges could use the two methods equally well to sort color prints and transparencies on the basis of quality of color balance and density. Another study *(1)* demonstrated that preferences for abstract forms were discriminated as well by use of a scale as by paired comparisons. Other studies indicated that scales have sensitivity comparable to paired comparisons when words or pictures of objects, instead of the objects themselves, serve as stimuli.

Our problem, then, was to determine whether or not a single stimulus or scale rating method would demonstrate differences in preference to the same degree as a paired comparison method when the subjects were untrained consumers expressing preferences for foods, and when the conditions are limited to those under which the paired comparison method can be used.

EXPERIMENTAL

The general plan was straightforward: a number of pairs of foods were tested for consumer preference with half the people using the paired comparison method and the other half a rating method.

Measuring instruments. These consisted of 2 printed forms. One form used to evaluate preference for the food items was the hedonic scale *(9)*, a 9-interval scale ranging from *like extremely* to *dislike extremely*. There is good evidence that the hedonic scale is an adequate one *(11)*. The other form was used to record which of a pair of samples was preferred.

No "equal" judgments were allowed in the paired preference tests, the observer being required to choose one of the samples. A forced choice is not required on the scale; 2 samples may be rated alike.

Subjects. Male and female employees of the Chicago Quartermaster Depot were used. They had no knowledge of the problem and not more than 5% had technological knowledge of foods. Since the subjects were drawn from the pool utilized for most of our preference studies, most of them had had previous experience with the hedonic scale, the paired preference tests, or both.

Serving procedures. The samples were served in coded dishes to the subjects who sat in booths separated from each other and from the kitchen. The subjects were told only the type of item, such as "scrambled eggs," and the number of samples they would receive. The position of samples in pairs, and the order of the individual samples or pairs, were randomized. A 30- to 40-

[a] This paper reports research undertaken at the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 521 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] Presented in part at the Fourteenth Annual Meeting of Institute of Food Technologists, Los Angeles, California, June 29, 1954.

second interval separated the return of one sample and the serving of the next.

Food items. For each of 8 food items one or 2 treatments were chosen, treatments which might be expected to differ in preference from the control. For 4 items one treatment was used, and for the other four, 2 treatments. Each treatment was paired with the control to be tested statistically for difference by both paired comparison and hedonic scale methods. However, in using the scale method when 2 treatments and a control were involved, the 3 samples were presented successively. The treatments and their controls are shown in Table 1. In all, 12 differences were tested by both methods.

In the 3-sample tests, the samples were on a continuum in several cases but not in others. Those on a continuum are represented by such samples as fresh milk plus 25% or 50% evaporated (reconstituted) milk; those not on a continuum are represented by such items as applesauce with either addition of sugar or addition of cinnamon. Another kind of variable used with different items was that of processing, such as holding one of a pair of samples on a steam table to produce deterioration, or altering the size of the pieces of meat in a canned beef and gravy. The 8 items used represented a sampling of dairy, meat, fruit and vegetable items.

Experimental design and analysis. Each pair of samples was rated on the hedonic scale (Method A) by approximately 20 subjects, and also submitted for choice of preferred item (Method B) by approximately 20 subjects. On one of 2 days, for a given pair of samples, the testing sequence ABBA was employed: 10 observers using the hedonic scale then 20 the paired comparison method, then 10 the hedonic scale. On another day, for the same pair(s) of items, the pattern was the reverse —BAAB. This served to balance out time effects, at least partially, and also provided replicates of each measure.

The scale categories were assigned successive integers from 1 to 9 beginning at the *dislike* end, and the ratings then treated quantitatively *(9)*. In testing for a difference in the hedonic scale mean ratings of 2 samples of an item (where each of 20 subjects rated both samples), Student's "t" was applied. The use of the variance of the difference in rating for the 2 samples (among the 20 subjects) in a t test with 19 degrees of freedom allows for the correlation between the two sets of 20 ratings. To afford a counterpart, for the paired comparison method, of the hedonic scale t, the arc sin (anglit) transformation *(4)* was applied, with the continuity correction, to the percent preferring one sample over the other. The normal deviate of the experimentally obtained anglit from the anglit for a 50-50 preference was computed as the counterpart to the t statistic. This anglit-deviate, when applied to the normal distribution, gave a probability closely approximating the exact probability given in tables of the binomial distribution *(7)* for the obtained percent of preferences (from a 50-50 "universe").

A comparison of the rating scale and paired comparison methods is afforded in Table 1, which shows the 12 pairs of t values and the 12 corresponding pairs of anglit-deviate values. To test the hypotheses that the mean and the variance, for all 12 sample-pairs, of the differences between t and anglit-deviate are zero, an analysis of variance was employed. The assumptions of analysis of variance were met insofar as can be determined: the t and anglit for samples as large as twenty satisfactorily meet the assumption of normality; the distribution of replicate errors was also approximately normal. A mean difference (or method "main-effect") other than zero would indicate that "on the average," the t and anglit-deviate differ. A significant variance of differences (method x food-item interaction) would indicate that the difference between t and anglit-deviate varies from one sample-pair to another—perhaps according to the difference between pairs.

RESULTS AND DISCUSSION

The t values and anglit-deviates for the differences in preference for the 24 pairs of foods studied in sixteen sessions are presented in Table 1. The replicate values for individual sessions utilizing approximately 20 observers (in 2 cases N = 15, and in the replicate sessions N = 23) for each pair of foods indicates the variability that can exist with an N of this size. The data from the two sessions for each pair of foods were also combined to give an N of 40 (in 2 cases N = 38). The t's and anglit-deviates for the combined data are also given in Table 1.

TABLE 1
Values of t and anglit-deviate of 12 food items studied in replicate sessions

Control food	Treatment of "paired" sample	Individual sessions (N = 20)		Replicate sessions combined (N = 40)	
		Hedonic scale	Paired preference	Hedonic scale	Paired preference
		t	anglit-deviate	t	anglit-deviate
One pair or two single foods at a session					
Scrambled eggs with 0.25% monosodium glutamate	Held ½ hour on steam table	2.38 1.14	0.00 1.14	2.59	0.92
Canned beef and gravy	Meat cut in smaller pieces	2.05 1.44	—0.22 —2.61	2.51	—1.77
Meat loaf	Held one hour on steam table	1.99 2.11	2.61 0.67	2.90	2.45
Scrambled eggs	Held ½ hour on steam table	2.44 3.39	2.61 3.80	4.13	4.68
Two pairs or three single foods at a session					
Canned buttered spinach	Added 0.1% monosodium glutamate	1.14 1.25	0.00 0.42	1.63	0.16
	Added 0.2% monosodium glutamate	1.45 1.59	1.04 1.26	2.12	1.81
Canned buttered green beans	Added 0.15% monosodium glutamate	1.21 0.11	0.67 1.59	0.81	1.77
	Added 0.30% monosodium glutamate	0.83 —0.56	0.67 0.67	.71	1.13
Applesauce with 16% sucrose	6% additional sucrose	0.34 0.27	2.09 0.67	0.82	2.08
	Added 0.1% cinnamon	1.10 0.13	2.61 0.22	0.88	2.08
Fresh milk	Added 25% evaporated milk	1.82 0.30	1.59 0.67	1.45	1.77
	Added 50% evaporated milk	4.20 3.03	2.61 3.15	4.97	4.27

TABLE 2
Analysis of variance of the t's and corresponding anglit-deviates from hedonic scale and paired preference data for 12 food "pairs"

Source	df	Mean square	F ratio	P[1]
Food	11	3.69	5.41	<.001
Method	1	1.09	1.60	>.20
Interaction	11	1.32	1.94	<.10
Error (replicate)	24	.68		
Total	47			

[1] Probability that an F ratio at least this large could have occurred by chance.

The analysis of variance (Table 2) demonstrates clearly the comparability of the 2 methods for assessing preference. The highly significant food main effect shows only that which is already evident from inspection of Table 1; namely, the food variations led to a

wide range of differences in preference from one pair of samples to another—from a t of 0.0 to a t of 4.97. The lack of significance at usually accepted levels for method main effect points to the overall similarity of the 2 methods in detecting differences in preference. However, the most important term in the analysis is the food-method interaction because lack of significance for this term shows that, within the limits of error as determined by replicate sessions, the 2 methods yield the same level of significance for any pair of foods whether the average level of significance be small or large.

The difference in preference obtained by the two methods for beef and gravy is heterogeneous with respect to the other differences. If its effect is removed from the analysis on the basis of the concept of extreme values *(3)*, the F values for method and food-method interaction drop to less than 1, thus strengthening the argument that the 2 methods yield the same results.

The mean square values obtained from the t's and anglit-deviates for the combined data are very similar to those shown in Table 2. A full analysis cannot be shown because no error term (other than the interaction in which we are particularly interested) is available.

The data demonstrate that the scale rating method is as sensitive to differences in preference as is the paired comparison method when the samples to be rated are presented successively in the same session, so that conditions are comparable to the paired comparison method. In addition, the scale allows judgments to be made on a number of samples successively while paired preferences would require the preparation and tasting of many more samples to obtain the same amount of information. In this regard, it should be noted that in the studies using 3 treatments, the two that were analyzed as a pair were, with the rating method, separated by an intervening sample one-third of the times served. This suggests that the comparison of 2 samples in the same test session is made even when they are not evaluated consecutively.

There are additional advantages of rating scales, not demonstrated in this study, over the paired comparison or ranking methods, which have several inherent limitations. First, it appears that a given item is rated in the light of the person's past experience, both immediate and remote. Second, the scale provides information concerning the preference level of an item relative to other items, whether they be similar or dissimilar. This means that data can be compared from one test to another though usually with less precision than for data obtained within the same test session. Third, the descriptive categories of scales can be quantified or assigned numerical values. Although paired comparison data can also be scaled, it is a difficult and time-consuming process. Therefore, scale data can be much more easily handled than paired preference data by various statistical techniques.

SUMMARY

Rating scale and paired comparison methods were tested for comparability in detecting differences in preference. In the rating scale method the samples were presented successively or with one intervening sample at the same test session to approximate the limiting conditions of the paired comparison method. Twelve pairs of foods were used, with each pair run in two sessions to estimate the sensitivity with both 20 and 40 responses per pair of foods. The rating scale and paired preference methods were equally sensitive whether the difference in preference was small or large.

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Preparation of Tasty Vegetable Products by Deep-Fat Frying[a]

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Tasty vegetable chips, similar to potato chips, have been made from beets, carrots and parsnips. Deep-fat fried pea and lima bean embryo chunks have been prepared from overmature canning or freezing varieties of peas and lima beans and these had a delectable nut-like flavor. The best conditions of cooking (time, temperature and slice thickness) have been worked out for these products. The five vegetable items have been evaluated by both small and large informal taste panel groups for product quality and possible application. Although there were individual preferences for one product or another, on the whole they were greatly relished by the tasters and considered readily acceptable for snack items or fresh vegetable substitutes in a meal. A cooking oil of high stability gave products which retained their high quality after months of storage.

The oil contents and yields of the fried vegetables have been found and a method of partial degreasing has been proposed. Crude protein values have also been determined. Fried peas and lima beans are highly nutritious food items with about 20% protein and 30% oil contents. Carotene studies made on fresh and fried carrot slices showed carotene losses on frying but the fried slices were still very rich in this pro-vitamin A factor.

Ground peas or lima beans with smoked flavoring ingredients made excellent soup mixes which could be readily rehydrated in about 3 minutes.

The trend in food usage today is toward the precooked or prepared package that requires a minimum of cooking time on the part of the housewife. The great increase in the consumption of vegetables in frozen packs and the phenomenal development of the potato chip industry in the past ten years are two of the primary examples of this trend. It occurred to members of the technical staff of this laboratory that other vegetables besides potatoes might be processed in a similar manner to provide a palatable precooked product having the same appeal to the busy housewife.

Certain seeds and beans have been on the market in fat fried form for a number of years, but these products appear to be a result of national preferences that have come to this country from other lands. An example of this type is the fat fried ceci bean common in the Italian markets. Some vegetables are familiar snack items in every grocery store but in forms little resembling the original vegetable. Corn is the vegetable most used for this purpose but onion- or parsley-flavored carbohydrate mixtures have appeared on a more limited scale. Sweet potato chips have been prepared commercially by firms in the southern growing region and more recently in Denver *(7)* and it is claimed that these chips are very acceptable provided they are made from a newly developed variety of sweet potato *(1)*.

We have been told (personal communication) that tasty chips can be made from bananas, particularly the starchy one known as the plantain.

In the study of French fried vegetables carried on at this laboratory a preliminary survey was made on 12 vegetables. Of these, 5 showed real promise as acceptable food items. These were beets, carrots, and parsnips in sliced form and peas and lima beans in whole or seed form.

The various factors required for the preparation of successful chips and bean and pea chunks have been studied, and their acceptance by both large and small group taste panels has been investigated.

Variety, maturity, thickness of slice, time and temperature of cooking, and the type of oil used for the deep-fat frying are the factors influencing the final character of the finished product. These factors varied for each of the vegetables and it was necessary to study each separately.

When a product was prepared under a number of varying conditions, a small group of colleagues were invited to express an opinion on which condition they considered most satisfactory from the standpoint of taste and texture. The taste was largely a question of, "did they like it or not?," and the texture was one of crispness as against toughness or chewiness.

After the appraisal by the small laboratory group the conditions were selected for the preparation of quantities of chips, peas, and lima beans for large scale group tasting. Two groups, of about 300 people each, were served the various products and their preferences noted.

We also attempted to determine whether or not these people would be interested in buying the products on the market and for what purpose they might want to use them, i.e., as a vegetable, as a cocktail snack, or for use as a general food snack like salted nuts.

In studying the physical characteristics of the chips and bean and pea chunks, it was noted that they rehydrated in hot water within a few minutes and became as soft and pliable as a cooked vegetable. This led to the discovery that these deep-fat fried vegetable pieces might have possibilities for dehydrated soup mixes. We have made up a number of such soups from ground chips, peas, or peas and carrots with added flavoring and have submitted them to our small taste panel groups for appraisal.

Storage studies. Storage studies have been made on the 5 products under investigation. Since the oil used for the deep-fat frying was very stable, no question of rancidity of the oil was involved. The chips and peas

[a] Presented at the Fifteenth Annual Meeting of IFT, Columbus, Ohio, June 14, 1955.

[b] A laboratory of the Eastern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

and lima beans were stored in air tight jars in the dark at an average room temperature of 70° F. Changes in odor and taste were noted after varying storage periods. The results are presented under each vegetable studied.

EXPERIMENTAL PROCEDURES AND RESULTS

Preparation of vegetable chips. Beets, carrots and parsnips were sliced to 1/32-1/16 in. thickness with a standard rotary knife slicer manufactured by the Eagle Machine and Tool Company, Springfield, Ohio, Model 20 c.[6] This cutter was easily adjustable to slice at any thickness but the adjustment had to be checked with a micrometer gauging of the cut slice.

The deep fat fryer used in this study was a Hotpoint Fry Kettle Model HK3[6] having a capacity of 15 lbs. of fat. This model is available with either one or two baskets for holding the food product. We found both sizes very useful for different size batches. In most of this work ½ lb. lots of vegetables were fried in the smaller baskets and 1 lb. lots were fried in the larger one. The Calrod[6] heater of this fryer quickly brought the temperature of the hot oil to the thermostat setting required for each experiment even with the larger quantity of vegetable.

In an experimental study of the frying of new types of vegetable products, the type of fat used is of great importance. In our early experiments we used a hydrogenated or shortening type oil but this proved to be unsatisfactory because of the high melting point of the product. Because it was necessary to prepare our vegetable chips at lower temperatures than those normally used for potato chips the amount of oil absorbed by the products was somewhat higher. We found that the higher melting point oils tended to solidify on the surface of the product after a few days at room temperature. This solidified fat detracted from the quality of the finished vegetable from the standpoint of both appearance and taste.

At about the time our experimental work was starting on these vegetable products a new fat was introduced to the potato chip trade. This was called to our attention by a commercial chipper and we obtained a quantity for our experimental studies. The product is a modified coconut oil known to the trade as "Dri-Fri" manufactured by the E. F. Drew and Company, Inc., of Boonton, New Jersey.[6]

Two factors have influenced the suitability of this oil for our experimental studies. First, the oil does not precipitate on the surface of the product at ordinary room temperatures. Second, the oil is stable against oxidative rancidity for long periods of time both on the shelf and in the fried product. We have so far failed to detect any off-flavor due to rancidity in any of our fried products even though many of these are well over a year old at this time.

We are not in a position to predict how much this oil would be used for the commercial preparation of French fried vegetable products since economic factors unknown to us might influence its use. Its high degree of stability should be of real importance, particularly with peas and lima beans which might be canned for snack items or soup mixes and be held on the grocery shelf for long periods of time.

Peas and lima beans were also fried in modified coconut oil containing 0.13% of the antioxidant "Sustane"[6] which has been used successfully to inhibit the development of rancidity in potato chips.

After 9 months' storage in air tight glass jars kept at room temperature (70° F.) in a dark cabinet no rancidity could be detected in any of the products by our taste panel members. Even longer periods of storage showed no appreciable differences between the treated and the untreated products.

With the beet, carrot and parsnip chips which would probably be marketed within a few weeks after their preparation, other types of commercially available oils such as peanut, corn or cottonseed would probably be as satisfactory as "Dri-Fri."

Table 1 shows the data on the preparation of good quality chips and pea and lima bean nuggets and the relative stability or shelf life of the products.

Variety and maturity of the various vegetables were very important in their successful production and many experimental trials were made before the best conditions were found. A few of the more important factors should be mentioned.

All vegetables were thoroughly washed before cooking; beets, only, were peeled.

Beets: Small bunching beets (1½-2 in. diam.) gave bitter dark chips and so only larger starchy beets could be used.

Carrots: Carrot chips could not be made satisfactorily from the heavy cored types like Danvers or Nantes Half Long or Red Cored Chantenay since it was impossible to obtain uniform cooking of the core and cortex sections of the thick roots of these varieties. The long bunching types cooked to a uniform crispness in the time specified.

Parsnips: Only the one parsnip variety shown in the table was available, and this was entirely satisfactory for the preparation of parsnip chips. The size was not as important as with beets although commercial medium and large grades were preferred. Parsnips can be obtained in this area (New Jersey, New York, Pennsylvania) from mid-fall to late winter, those coming out of winter storage being as good for chips as fall roots. Roots

[6] The mention of commercial products is not to be construed as an endorsement by the U. S. Department of Agriculture over other products not mentioned.

TABLE 1

Preparation of deep-fat fried vegetables

Vegetable	Variety used	Maturity	Average moisture content		Frying conditions		Time range	Average shelf life under standard storage conditions[1]
			fresh	after frying	thickness of slice	temperature		
			%	%	*inches*	*° F.*	*minutes*	*months*
Beets	Crosby's Egyptian, Early Wonder, Detroit Dark Red	Mature 2½-4 in. diam.	89.0	3.1	1/16	300	5-6	12
Carrots	Imperator or California Bunching	Any size, 1 in. to 1½ in. crown diam. preferred	89.0	3.3	1/16	275	5-6	2
Parsnips	Pa. Guernsey	Any size, 2-3 in. crown diam. preferred	78.0	2.5	1/32-1/16	275	3-4	12
Lima beans	Fordhook	Large overmature	63.0	3.9[2]	whole bean	300	9-10	12
	Henderson	Mature	65.0	1.8[2]	whole bean	300	8-9	12
Peas	Glacier	Large overmature	69.0	3.0[2]	whole pea	300	8-9	12-20
	Rainier	Large overmature	77.0	3.8[2]	whole pea	300	8-9	12-20

[1] See introduction under "Storage Studies."
[2] Embryo.

dug from the ground after freezing are a little sweeter and give a slightly browner chip which, nevertheless, is very tasty.

Parsnips showed some variation in density and it was necessary to try each lot experimentally to determine the best cut. One lot of roots of lower than average moisture content (73%) obtained during a very dry fall period had to be cut to 1/32 in. to give a crisp chip. A 1/16 in. cut gave a tough chip that did not break easily in the mouth. Most of the roots obtained from winter storage gave a satisfactory chip with a 1/16 in. cut.

Lima Beans: Both Fordhook and Henderson varieties of lima beans made satisfactory fried lima nuggets. The overmature Fordhook is greatly preferred and both extra large white or green beans, as rejected on the packing house sorting lines, made an excellent fried product. Since the amount of rejects is not too great at any one time a constant supply would have to be obtained by allowing the field beans to mature an extra few days before vining. Dried white limas (Butter Beans) could also be used for the preparation of French fried lima nuggets after a period of at least 12 hours of soaking prior to frying. These were a little harder than the nuggets prepared from the fresh beans and did not have the same fresh bean flavor. The shelled green beans required a 3-minute blanch in boiling water and a brief drain before frying so the seed coats could be removed by cooking and rubbing or brushing off in a manner similar to that used in removing the skins of peanuts.

Peas: When first tested, peas appeared to be about the most unlikely prospect for deep-fat frying of any of the vegetables examined. Our experimental studies of peas revealed one basic factor which must be observed, i.e., only hard starchy peas made successful French fried pea nuggets. When prepared from shelled fresh market pod peas those held on a No. 5 or 13/32 in. mesh screen gave a satisfactory fried product whereas those passing through this screen and held on a 9/32 in. screen were a mixture of mature and immature seeds. The immature seeds (those normally used for freezing and canning) were less starchy and contained too much sugar and moisture to be used for frying.

As with lima beans, freezing plant [4] rejects were kindly made available for our studies and peas showing tenderometer readings of 150 or over made excellent nuggets. Although more overmature peas than limas would normally be available at canning and freezing plants it is probable that growers could be induced to supply these peas from fields especially grown for this purpose along with those which often occur as hot weather surpluses. The overmature peas can be vined with less damage and hold better in storage than immature peas. After washing in cold water we have held them in 40° F. storage for 48 hours or longer without loss of quality in the finished product. Peas do not require blanching for seed coat removal since most of the skins come off during frying. In the case of the very ripe yellowing seeds they often pop off with considerable violence and the operator should be protected from hot oil by a screen. Peas like limas are more palatable when the seed coat is removed by mechanical action and only the whole embryo or separated cotyledons were used. Fried peas should be stored in light tight containers since light appears to catalyze the breakdown of the chlorophyll and carotenoid pigments giving a product of undesirable color having a hay like odor.

Centrifuging: Since vegetable chips must be prepared at temperatures of 275°-300° F. for slightly longer cooking times than potato chips, the absorption of oil is somewhat higher. We found that some of this oil could be removed by centrifuging in a basket type of centrifuge. Using a basket of 11 inches outside diameter and a maximum speed of 1500 r.p.m. for beet and 2000 r.p.m. for carrot and parsnip chips, the oil content could be reduced by 4-11% as shown in Table 2.

Salting and flavoring of chips and nuggets: All of the fried vegetable products were salted with fine chip salt after cooking and draining or centrifuging. Other flavored salts or flavoring agents were tried on the various preparations and their use would be a matter of individual preference. Celery, garlic, parsley salts and a savory salt with sage and other spices with monosodium glutamate were used. A smoked "bacon flavor" product [5] was also used on the chips.

Soup mixes from peas and lima beans. For the preparation of soup mixes, deep-fat dehydrated peas and lima beans were ground in a Wiley Mill to a fine powder (1 mm. mesh screen). Because of the high fat content of these peas and beans, it was necessary to cool them prior to grinding by placing them in a deep freeze unit or packing them in dry ice. It was also essential to cool the grinding mill and keep it cold with dry ice during the grinding. Some surface frosting occurred under humid conditions but this could be eliminated by allowing the powder to warm up in a 250° F. oven for a short period of time after the grinding. The resulting dry powder was free flowing and could easily be mixed with other ingredients or packed in containers for storage.

Ground peas made a tasty soup by simply adding 50 g. of powder to 250 ml. (approximately 1 cup) of boiling water and allowing the mixture to simmer (194° F.) for 3 minutes. We did not salt this plain soup mix, allowing our panel members their choice in this respect. A much more popular soup mix was made by premixing 7.5 g. of smoked "bacon flavor" powder [5] with the 50 g. of dehydrated pea powder before addition to the hot water. This mixture gave a delectable smoked ham flavor to the soup which compared favorably with the old time split pea soup made by cooking split peas for several hours with a good chunk of smoked ham.

Both the Glacier and Rainier peas made very acceptable soup mixes. Whole dehydrated peas (embryos and seed coats) as well as separated embryos could be ground for soups but it was the opinion of our taste panel members that a slight grittiness could be detected in the soups containing the seed coats.

We have been told by private communication that one of the objections to presently available precooked pea soup mixes is their fineness or nongranularity. A ready cure for this homogeneous condition would be to incorporate chunks of French fried peas in the mix. Since these chunks rehydrate to a soft particle, yet remain intact, they could be used to impart a sense of "feel" to the soup mix. We have added chunk size pieces (about 1/16 to 1/8 in.) to our fine ground soup mix and found this combination very satisfactory.

Ground lima beans, either plain or with "bacon" powder, were made into tasty soups by the addition of approximately 20% by weight of powder to hot water and simmering for three minutes.

Analysis of French fried vegetable products. Moisture determinations were made on the fresh vegetables by drying to constant weight in a Dietert Moisture Teller.[6] The moisture content of the fried products was determined in a Brabender [6] apparatus. Average moisture values on a number of samples of the fresh and dehydrated vegetables are shown in Table 1. Table 2 shows the average oil contents of these same samples. The values were obtained by the method of Williams and McComb *(6)* in which the chips were ground and repeatedly extracted with hot carbon tetrachloride then reground and extracted as before. The filtered extract was evaporated to dryness on a steam bath. The weight of the oil extracted from the fried vegetables is expressed as:

$$\frac{\text{Weight of oil} \times 100}{\text{Weight of Sample}} = \text{Percent oil in chips}$$

Table 2 also shows the yields of edible fried products obtained from the fresh vegetables. The yields of the peas and lima beans are based on the weights of the recovered embryo fractions rather than the embryo and seed coat. In column 7, however, which shows the amount of oil per 100 lbs. of fresh vegetable, both the embryos and seed coats are included since both remove a certain amount of oil from the cooking kettle.

We have not as yet made complete studies of nutritional values of French fried vegetable chips and pea and lima bean nuggets. These products are not proposed primarily as dietary items but rather as unusual snack items. They do, however,

[4] Seabrook Farming Corporation, Bridgeton, New Jersey. (cf.[5]).

[5] Dell Food Specialties Company, Beloit, Wisconsin. (cf.[6]).

TABLE 2

Analysis of deep-fat fried vegetables

Fat and protein contents, yields and fat consumption

Fried vegetable	Fat content		Protein		Yields	Fat used per 100 lbs. fresh vegetable
	after frying	after centrifuging	as is basis	fat free basis	based on fresh vegetable	
	%	%	%	%	%	*lbs.*
Beet chips	50	43	7.3	14.7	23	11.5
Carrot chips	51	40	2.9	6.0	23	12.0
Parsnip chips	47	43	5.5	10.4	43	20.2
Lima bean:						
Fordhook, fried embryo	27	....	19.1	26.1	38	11.3[1]
Henderson, fried embryo	31	....	16.1	23.4	41	15.0[1]
Peas:						
Glacier, fried embryo	33	....	22.0	32.8	34	14.5[1]
Rainier, fried embryo	38	....	22.5	36.3	21	12.3[1]

Protein contents of dehydrated lima beans and peas

	Oven dried					
Lima beans, Fordhook, dehydrated embryo	1.1		24.8	25.1		
Peas, Glacier dehydrated embryo	2.3		31.0	31.7		

[1] Embryo and seed coat.

offer certain dietary factors which should not be ignored in a consideration of their use. All are high in carbohydrate and oil and thus could serve as a quick energy food item. Carrot chips are exceptionally rich in carotene (provitamin A) and peas and lima beans are a concentrated source of protein comparable to oil seed products such as roasted peanuts and other nut products.

To determine how well carrots retained their vitamin A value we made a number of carotene assays by the method of Wall and Kelley *(4)* on both fresh and French fried carrot slices. Because of the high oil content of the chips, the foaming alcohol and petroleum ether method, as described for fresh plant materials, was found most satisfactory for chips. This was followed by saponification of the extract with 10% alcoholic KOH as described by Wall, Kelley and Willaman *(5)*.

Fresh carrots of 87.6% moisture content had a carotene value of 127.6 μ/g. on an "as is" basis and a value of 1025 μ/g. on a moisture free basis. French fried carrot slices showed 313 μ/g. of carotene on chips of 48.9% fat content or 639 μ/g. on a moisture and fat free basis. These figures show a loss of 38% of the carotene after frying at 275° F. Because of the concentration of the carrot slices during frying, the fried chips actually contained about 2½ times the amount of carotene of an equal weight of fresh carrots.

Protein values of the chips, peas and lima beans were found by determination of the total Kjeldahl N by the AOAC semi-micro Kjeldahl method *(3)*, as recently modified by Ogg *(2)*, on solvent extracted vacuum oven dried samples. The high oil content of these French fried products seriously interfered with the Kjeldahl nitrogen procedure and solvent extraction was essential to an accurate determination.

The samples were extracted with hot carbon tetrachloride as described above. Sixteen-hour Soxhlet extractions of the residues with ether yielded only 1.15% additional fat for the peas and 1.06% for the lima beans. This represents about ½ of the lipid content of the dehydrated peas and the full lipid content of the lima beans.

The protein contents of the 5 French fried vegetables are shown in Table 2. For comparison, Table 2 also shows the protein contents of dehydrated lima bean and pea embryos. It can be seen that there was no appreciable loss of protein during the frying of these two products.

The amino acids of these peas and lima beans are being studied and the results will be published at a later date.

DISCUSSION

In preparing new food items, such as those described in this paper, laboratory scale experiments serve primarily as an indication of what can be done in the way of preparing large quantities of new precooked foods. Evaluation of the particular group of products described above is uncertain at best. We have tried by using small taste panel groups (10-16 people) to determine the optimum conditions for preparation of the products. The only point on which all the panel members agreed was that the products should be crisp or even crunchy in the case of pea and lima bean products.

The optimum length of cooking time varied within narrow limits according to individual preferences. Some of the panelists like a slightly scorched or toasted flavor, whereas others preferred the stronger vegetable taste.

There was a considerable variation of opinion on the most desirable amount of oil in the chips and pieces. Some preferred the original oil content after frying while others felt that the removal of 5 to 8% of this oil by centrifuging was advisable.

Salting and flavoring of the products likewise occasioned numerous comments as a result of individual tastes. The general conclusion along this line was that most panelists preferred salty products but a few were satisfied with very small amounts. Carrot and parsnip chips were sweeter to the taste than the other products and, in general, required less salting or none at all as far as some tasters were concerned.

Finally, people vary greatly in their liking for fresh vegetables. It is doubtful, therefore, whether or not it is possible to obtain an unbiased opinion of the French fried products made from the 5 different vegetables. At the risk of prejudicing possible future consumers of these products, we are presenting a few overall comments on the 3 vegetable chips and the 2 nut like pea and lima bean chunks. These are summarized below. We have failed so far to find anyone who did not relish the French fried peas. When asked to compare the slightly more mature Glacier peas with the greener sweeter Rainier peas, there were individual preferences but if given either one alone they were consumed on the spot. Lima bean chunks were well liked by the majority of the tasters but a few considered them lacking in a distinctive flavor like the peas, and some found them harder in texture. The toasted flavor was somewhat preferred for the lima bean chunks.

Beet chips presented the greatest flavor problem. A few people refused them because of their intense dislike for beets as a vegetable. In contrast some true beet lovers consumed all the chips we could provide and even asked for more. In general, they were considered to have a slightly bitter after-taste which may well be due to their high concentration of organic acid salts. The deep red purple color of these beet chips was considered novel for cocktail use by many but a few felt that only light brown chips similar to potato chips would have sales appeal.

Carrot chips were likewise deeply colored but the orange color was not considered as novel by the color conscious tasters. The fresh carrot chip flavor was well liked but the stale taste of over-age chips was quickly detected by most tasters. It was evident to us that carrot chips could not be carried on store shelves for over 2 months.

Parsnip chips were well liked by the majority of our taste panel members in spite of the fact that many did not like parsnips as a cooked vegetable. More than half of our tasters were unfamiliar with this vegetable in any form. However, no prejudice toward the chips could be noted in either case. More often the first reaction was an expression of surprise that such a good product could be made from such an uncertain vegetable. The light golden brown color of the parsnip chips was considered satisfactory by the most discriminate color observers.

Large group tasting. The reactions of about 300 nontechnical people toward the three vegetable chips, beet, carrot and parsnip, were obtained at an open house meeting at this Laboratory. The general opinion was that the parsnip chips were the most tasty and unusual of the three but, as with the small taste panel groups, some favored beets and others, carrots. Most of the housewives asked when they could buy these products on the market. Many of the women were impressed with the vegetables in this new form and felt that they might be able to get their children to eat more vegetables if they could obtain these chips. Like potato chips, they might be a popular school or after school snack for the energy consuming youngsters.

The fried chips, peas and lima beans were also presented at a national meeting of potato chippers. Several hundred people tasted these products at that time and the majority of comments were favorable. Many of these individuals, associated with the food industry, felt that the fried vegetable products would do well as an accessory line for the potato chip manufacturer. A few others felt that they would be competitive.

SUMMARY

The greatly increased consumption of precooked foods in the last few years has stimulated research on the preparation of vegetables in a form comparable to potato chips.

Beet, carrot and parsnip slices have been cooked in deep fat to yield tasty and attractive vegetable chips. Peas and lima beans have been prepared as crunchy pieces having a nut like flavor and appearance.

Variety and maturity studies have been made on each vegetable to determine the conditions best suited to this type of processing. The best temperature and cooking time for each was likewise found. Of the five vegetables studied, only lima beans required blanching prior to frying.

When cooked in a stabilized oil, the fried vegetables are stable over long periods of time (6-12 months) at room temperature. Carrot chips are somewhat less stable than the other products due to their high carotene content. Although some loss of carotene occurred during the short period of cooking, enough remained to make these chips a rich source of this vitamin A precursor.

Fried pea and lima bean nuggets are rich in protein, fat and carbohydrates making them highly nutritious food items. They can be eaten as pieces, like nuts, or made into a spread by grinding. They can be converted to a fine powder by freeze grinding and, mixed with suitable flavoring ingredients, they make an excellent dry soup mix which can be fully rehydrated in about three minutes in hot water.

Beet, carrot and parsnip chips can be used as a precooked vegetable or for cocktail snacks. They are particularly tasty when salted with garlic, savory or other commercial flavoring salts or spices.

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Estimation of Free Starch in Potato Granules and Its Relation to Consistency of Reconstituted Product

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The consistency of reconstituted potato granules is influenced by the free soluble starch in the dehydrated product. Mechanical damage to the product causes an increase in free starch, which results in lowered quality due to a pasty consistency. A rapid colorimetric method for the estimation of soluble starch under specific conditions is described. The value obtained is related to consistency of reconstituted potato granules and is useful in laboratory research and industrial development work. This relationship seems limited to processes in which similar raw material and conditions of manufacture are used.

In developmental work on a process for production of potato granules (dehydrated mashed potatoes) described previously *(4, 5)*, a rapid method was needed for evaluation of texture of the reconstituted product. In prior researches the evaluation of factors contributing to pastiness of final product was variously approached by microscopic observation of broken cells *(3)*, estimation of soluble starch by viscosity measurement of a centrifuged warm water extract *(1, 2)*, and qualitative chemical test for presence of free starch to establish the appropriate tempering period prior to drying *(6)*.

In the potato granule process it has been observed frequently that increase in pastiness in reconstituted mashed potatoes is accompanied by an increase in easily extracted soluble starch. In the search for an objective measurement of product quality, this relationship was investigated. The "easily extracted starch" or "free starch" was defined, from preliminary investigations, as starch extracted by an excess of distilled water at 150° F. (65.5° C.). The soluble starch extracted can be readily estimated by photoelectric measurement of the intensity of blue color formed by addition of iodine to the filtered extract.

The work described in this paper was done in connection with research on potato granules in which an index of blue value was extensively used as an objective measurement of texture of reconstituted potato granules. The method is described and its limitations are discussed.

DETERMINATION OF THE BLUE VALUE INDEX

A 2.5-gram sample is carefully weighed on a torsion balance having a beam graduated to 0.1 g. A 600-ml. tall beaker is set up with an agitator fitted with a variable-speed drive. About 4 liters of distilled water (enough for 6 samples) is heated in a flask to about 180° F. (82.2° C.) and 500 ml. is quickly measured in a graduated cylinder, which has been warmed with hot water, and poured into the beaker. The water is stirred at a moderate rate and when the temperature reaches 150 ± 1° F. (65.5° C.) the sample is quickly added and agitation continued for 5 minutes, at a rate sufficient to suspend the powder.[a] The stirrer is removed and, after a minute or so, about 100 ml. of the slurry is poured into a folded filter (E and D 193-15 cm.).[b]

A 5-ml. portion of the warm filtrate is transferred with a pipette to a 125-ml. Erlenmeyer flask, containing 1 ml. of 0.02*N* KI_3 solution, measured with a pipette, and 44 ml. of distilled water measured with a 50-ml. graduated cylinder. A blank solution of 1 ml. of 0.02*N* KI_3 and 49 ml. of water is likewise prepared and used for each series of measurements.

The blue color intensity is measured with a Klett-Summerson Photoelectric Colorimeter fitted with a No. 66 red filter having a transmission range of 640 to 700 mμ.[b] The instrument is warmed up for a few minutes and then set to zero with about 5 ml. of the blank solution in the standard colorimeter test tube. The blank is then replaced with the blue solution containing the potato extract, after the tube has been rinsed with the latter, and the scale is read to the nearest mark. This reading is the Blue Value Index. If it is above 500 units, a more dilute solution is prepared in order to bring the reading back to the sensitive range. For example, if the reading is 600 units, the operator transfers 5 ml. of the filtrate to a flask containing 1 ml. of 0.02*N* KI_3 and 94 ml. of water and multiplies the reading by 2 to obtain the Blue Value Index. For this dilution, the blank should contain 1 ml. of 0.02*N* KI_3 and 99 water.

This empirical method although designed for speed rather than extreme precision gives reproducible results. When the procedure is closely followed and 6 samples are run at one time, duplicates should check the mean within 5%. The temperature of the first and last in a set of 6 will be approximately 149° and 151° F. when the samples are added. This difference is due to the cooling of the water while subsequent portions are being measured.

If only 3 samples are run at one time it is possible to control the temperature to about ± 0.5° F. This initial temperature is critical but slight variations in the subsequent decline in temperature have little influence on the result.

The effect of the initial temperature was determined for 2 samples of substantially different Blue Value Indexes (140 and 260 at 150° F.). They were run by the method described, with the exception that 5 different temperatures were used over the range from 145° to 170° F. (62.7° to 76.6° C.). Six determinations were made at each temperature for both samples. Blue Value Indexes for these samples increased 4.0 and 7.5 units per degree F., respectively. Based on the original values at 150° F., this increment was 2.9% per degree for both samples. The relation of the Index to temperature was linear for the 2 samples under these conditions. Maximum deviation of any point from the line was 2.1%.

It is convenient to dilute standard 0.1*N* KI_3 solution to 0.02*N*. This solution should be checked by titration with standard sodium thiosulfate solution. Iodine solutions should be kept in glass-stoppered bottles painted black and in a dark closet when not in use.

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[a] During the extraction period, drafts should be excluded from the working area.

[b] Mention of products does not constitute endorsement by the Department of Agriculture over others of a similar nature not mentioned.

EFFECT OF ABRASION OF GRANULES ON TEXTURE OF PRODUCT

In a study of the effect of mechanical damage on texture, the influence of other processing variables was elimininated by the use of a commercial sample damaged in the laboratory. Several 200-g. portions were abraded for 2 minutes in a food blender and then combined. Some of this damaged material was mixed with the original sample in a 3 to 2 ratio. Thus there was available material in 3 relative stages of physical damage: 100% damaged, 60% damaged, and no damage. Blue Value Indexes were determined in duplicate.

Samples were reconstituted for texture appraisal as follows: heat 0.7% salt solution to boiling and immediately measure 480 ml., cool to 180° F., stir in 100 g. of granules with 20 to 25 strokes of a fork for 10 to 15 seconds, and continue stirring for a total of 100 strokes and total time of 1 minute. The standard procedure now used at this Laboratory for reconstituting granules is described by Wood *et al. (7)*. The samples were coded and judges were unaware of the presence of the duplicates. Sixteen trained judges manipulated the samples with a fork and scored them 3 times for degree of rubberiness. The scores were converted to ranks for the analysis, with rank 1 = *least rubbery*, rank 4 = *most rubbery*. Results are shown in Table 1. The present procedure is to rank directly. The method of analysis and calculation of the LSD are outlined by Wood *et al. (7)*.

TABLE 1

Effect of abrasion on texture and Blue Value Index of potato granules

Number	Original percent	Damaged percent	Blue Value Index	Texture rank[1]
1	100	0	83	1.38
2	60	40	149	2.47
2	60	40	149	2.54
3	0	100	234	3.61

[1] Rank 1 = *least rubbery*; rank 4 = *most rubbery*.
LSD at 5% = 0.40.

The texture scores for the 40% damaged samples were not significantly different from each other. It is evident that, under these specific conditions of abrasion, as damage was increased the texture suffered to a very significant degree.[6] As rubbery consistency of the reconstituted mashed potatoes increased, there was a concurrent rise in the Blue Value Index of the granules from which they were prepared.

BLUE VALUE INDEX AND TEXTURE OF COMMERCIALLY PRODUCED GRANULES

It was important to test the application of the index to the evaluation of texture of granules of industrial manufacture where there are sometimes large differences in consistency due to the many variables that may occur in one plant. Accordingly, a series of samples of varying texture produced over an extended period was obtained from a manufacturer, together with ratings for texture of the reconstituted mashed potatoes as determined in the producer's laboratory by one technician. Blue Value Indexes were determined and results compared, as shown in Table 2.

The Index tended to increase for the samples that the technician indicated were more pasty. Since only one set of samples was evaluated, the relation of the Index to the texture designation cannot be regarded as an absolute factor that would necessarily apply in another process.

The Index has been useful as a numerical check, however, on subjective texture ratings within a process for development and control work, particularly to indicate extent of abrasion at different stages in the system. For example, an extensive series of tests was run with production equipment in one of the plants operated by the above-mentioned manufacturer to study the effect of abrasion in the conveying system on texture of product (Table 3). In Series 1, normal operating conditions with the add-back process prevailed. This process requires recycling of

[6] The designation LSD at 5% = 0.40 (Table 1) indicates that a difference of 0.40 between any 2 samples could occur by chance in only 5 cases in 100.

TABLE 2

Texture and Blue Value Index of a series of samples of potato granules. One process

Number	Texture (subjective)	Blue Value Index
1	Good	98
2	Good	182
3	Good	189
4	Pasty	234
5	Pasty	258
6	Very pasty	275

a portion of dried product for admixture with fresh cooked potatoes to reduce the moisture content from about 75 to 35%. At this moisture level, a friable moist powder is obtained that can be dried to a particulate form consisting substantially of separate, intact tissue cells. One cycle is considered as the time required for the freshly cooked potato to pass through the system and be returned in part as a portion of the add-back powder. Usual fluctuations in Blue Value Index and texture occurred with the exception that, in the last 3 cycles, there was a sharp increase in the Index, indicating an unexplained change in conditions that was not confirmed by any significant variation in texture as determined subjectively. In Series 2, the conveyers were by-passed. With otherwise normal process factors, including addition of fresh mash, the texture quality improved with a decrease in the Index. It would seem that by-passing the conveyers removed a source of abrasion and impact that had caused damage to the potato tissue wtih consequent release of free starch. For a further check, the dried product produced in the eleventh cycle of Series 2 was circulated through the conveying system 11 times (Series 3). As is shown, the Index increased and texture became more pasty or rubbery. These studies on texture with confirmation by the Blue Value Index

TABLE 3

Texture and Blue Value Index of potato granules in an industrial process

Cycle	Normal run				Series 3—granules passed through conveyer[1]	
	Conveyer used—Series 1		Conveyer by-passed—Series 2			
	Texture[2]	Blue Value Index	Texture[2]	Blue Value Index	Texture[2]	Blue Value Index
1	..	.....	3	109	5	88
2	4	104	5	108	3	108
3	5	102	3	94	6	140
4	3	109	5	86	4	132
5	..	.....	6	82	6	143
6	5	120	7	67	4	162
7	5	112	6	78	4	144
8	6	130	7	71	1	178
9	5	202	6	67	2	192
10	5	232	7	76	2	206
11	..	.....	7	70	2	218

[1] Feed is cycle 11, series 2.
[2] Subjective texture score: 7 = *good, not pasty* and 1 = *slightly pasty* (by manufacturer's designation).

have indicated areas in the process where mechanical damage to the product occurs. The need seems evident, in plant design, to reduce to a minimum the transport of potato granules through conveying systems where they will suffer impact or abrasion.

LIMITATIONS IN APPLICATION

As implied heretofore the Blue Value Index will not necessarily vary with the texture when there are substantial differences in process or raw material. It was possible to examine a number of samples supplied by members of a conference in 1952 on potato granule technology, who represented manufacturers and research groups. Seventeen people judged the quality of the reconstituted mashed potatoes. Texture was evaluated on the basis of 10 = *excellent* and 1 = *poor*. All samples were coded.

The texture scores and Blue Value Index are listed in Table 4. In this table the deviations in the relationship of Blue Value Index to texture score may be due to variables in the process aside from mechanical damage to the potato tissue. For example, in this series of samples there were known differences in variety of raw material, processing methods, and storage history of the potato granules. It is noteworthy that, after 8 months' storage at room temperature 7 of these samples showed a decrease in Blue Value Index of about 12% and 2 were substantially unchanged. The reduction of this Index indicates a decrease in solubility of starch or amylose during the storage period.

TABLE 4
Texture and Blue Value Index of samples appraised at the 1952 potato granule conference

Number	Blue Value Index	Texture[1]	
		Range	Mean
1	201	4-10	7.9
2	91	5-10	7.9
3	97	4-10	7.6
4	137	4-9	6.8
5	310	3-10	6.6
6	72	3-8	6.3
7	226	3-7	4.8
8	135	1-8	4.7
9	183	2-6	3.6

[1] Subjective score: 1 = *poor;* 10 = *excellent;* 17 judges.

CONCLUSIONS

The Blue Value Index, as an indicator of cell damage, has been very useful in developmental work in the laboratory and pilot plant and has been employed in industrial production of potato granules. However, in these fields, at least for the present, critical evaluation of substantial changes in process development must ultimately depend on subjective assessment of reconstituted product.

In a particular process when major changes do not occur, the Blue Value Index is useful as a rapid numerical check on subjective texture evaluation. Further, since it measures small changes in an important texture factor, it has considerable value in developmental work to show at what stage in the process the damage occurs and in the plant to indicate when the process drifts out of control.

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Maturity Indices in Lima Beans[a]

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In order to evaluate possible maturity indices, various physical measurements were made on developing lima beans from the flowering stage on. The measurements suggested certain attributes which could be tested with frozen lima beans. Those chosen were tested against alcohol-insoluble solids and moisture content in frozen lima beans. A new index (dry weight/fresh volume) is suggested for further evaluation.

A preceding paper *(11)* explored the semantics of the term "maturity," as applied to processed vegetables, and evaluated several empirical indices of maturity in frozen lima beans. Inasmuch as the materials of that study were relatively homogeneous, little relationship was found between certain estimates of physiological maturity and A. I. S. values as the processing conditions were varied.

In order to evaluate further presumptive indices of physiological maturity, it is necessary to study changes in the bean seed during its development. Such an investigation can then indicate the direction in which empirical measurements of maturity may be sought [*cf.* the work of Bisson and Jones *(1)* on peas]. A microscopic investigation of changes in the seed coat, endosperm, nucellus, and embryo of the developing lima bean *(8, 9, 10)* suggested several possible physical

[a] A report of work accomplished in part under contract with the U. S. Department of Agriculture as authorized by the Agricultural Marketing Act of 1946. The contract was supervised by the Fruit and Vegetable Division of the Agricultural Marketing Service.

attributes for further analysis. On the other hand, some attributes were found to be inadequate, including that recently proposed *(7)* of the structure of the hilum of the starch grain. Not only was the development of this hilum variable within the individual seed and among different seeds of the same age, but there were also characteristic varietal differences. Thus, in the Evergreen variety the hilum often maintains the form of a small dot, even in overmature beans. Moreover, following gelatinization of the starch grain with blanching, these characteristics of the hilum become quite obscure, and hence this method is inapplicable to frozen lima beans.

Based on the histological study, an evaluation of certain physical attributes of the developing seed was made. The measurement of physical properties demands neither as elaborate skills nor as expensive equipment as does the measurement of chemical properties. These physical attributes were then explored with frozen lima beans and evaluated as possible maturity indices. This paper presents the results of these analyses.

MATERIALS AND METHODS

Materials. For the basic study of changes in physical qualities during seed development, *2* varieties were used. Plots of Henderson Bush (thin-seeded) and Evergreen (baby potato) lima beans were set aside by the Associated Seed Growers' Station in Milpitas, California. At full bloom, all previously set pods were removed by hand. Specimens were collected at *2-3* day intervals for 45 days for physical analysis. At the end of this period, the pods were becoming thin and papery, and the beans were starting to shrink and harden.

For testing the chosen analyses on processed lima beans, several sources of materials were employed. About the time of optimum maturity, samples of Henderson Bush beans at Milpitas were collected at *3*-day intervals, to give five collections in all. Similarly, 5 collections of Thorogreen beans were made at Davis, California. These were vined in a laboratory viner and then processed as indicated below.

Commercially vined beans of the Wilbur and Clark's Bush (Patterson, California) and Evergreen (Alviso, California) varieties were also obtained. Each of these collections was subdivided into 5 groups on the basis of flotation in sugar solutions of various concentrations (*i.e.*, sinking in *32%* sucrose; floating in *32%* and sinking in *30%*; floating in *30%* and sinking in *28%*; floating in *28%* and sinking in *26%*; floating in *26%*). A sample of Concentrated Fordhook beans grown at Davis was vined at the laboratory and subdivided into 4 groups by sugar flotation, as was a group of commercially vined beans of the same variety from Mountainview, California *(see 11)*. In these *2* cases, the sugar solutions used were *24%*, *21%*, and *18%*.

All beans were blanched for 3 minutes in steam at *212°* F., cooled in water 30 seconds, and sealed in No. *2* cans. Freezing (and storage for 7 months) took place at —10° F. in circulating air.

In addition, the beans analyzed in the earlier study *(11)* were included in the computations of the present study on indices. Their treatments are described in that investigation.

Method of analysis. Preparation of samples and measurement of moisture and alcohol-insoluble solids (A. I. S.) have been described earlier *(11)*. Volumetric measurements were made by immersing whole beans in a measured volume of water in a 100 ml. graduate cylinder. Embryo/seed-coat dry weight ratios were determined as previously described *(11)*. The value of the "fresh" weight ratio was also ascertained.

RESULTS AND DISCUSSION

Developmental aspects. Both the fresh and dry weights of the beans increase continually during seed growth (Table 1). Table 1 gives data for Henderson Bush beans; the data for the Evergreen variety are essentially similar. Initially slower, the rate of growth becomes typically more rapid as time goes on, finally slowing down again with the onset of seed maturation. The rate of dry weight increase is considerably more rapid in maturation than is the rate of fresh weight increase.

TABLE 1
Analysis of raw Henderson bush lima beans

Days after flowering	Fresh weight of 100 beans	Dry weight of 100 beans	AIS DWB[1]	Moisture	Embryo/seed coat		Dry weight/ fresh volume
					(dry weight)	(fresh weight)	
	g.	*g.*	%	%			
20	5.932	1.041	44.53	82.45	0.742	0.822	
22	8.399	1.564	55.00	81.38	1.109	1.120	0.187
24	12.528	2.521	56.84	79.88	1.553	1.480	0.209
27	24.660	5.469	62.39	77.82	2.617	2.226	0.238
29	36.816	10.021	69.90	72.78	3.911	2.887	0.297
31	41.031	10.957	72.27	73.30	4.373	3.072	0.275
34	55.030	16.557	75.22	69.91	5.754	3.984	0.309
36	69.247	24.954	82.10	63.96	7.840	4.411	0.367
38	70.171	25.278	81.70	63.98	7.517	4.445	0.394
41	71.327	28.382	81.83	60.21	8.807	4.623	0.411
43	79.447	30.653	82.09	61.42	8.361	4.672	0.407
45	81.926	33.309	84.54	59.34	9.355	5.309	0.444

[1] Dry weight basis.

The content of moisture (fresh weight basis) and alcohol-insoluble solids (dry weight basis) during the course of bean development is shown graphically for Evergreen beans in Figure 1. Note that the *2* characteristics have almost uniformly opposed trends, as might be expected. (The curves for Henderson Bush beans run in virtually like fashion.) The course of the trends is validated by microscopic observation of the developing embryo and embryo sac *(9, 10)*. At first richly protoplasmic, the embryo sac enlarges rapidly as the seed grows, becoming filled with a voluminous watery vacuole during the first *2* weeks of development. Subsequently, the embryo slowly enlarges to fill this sac, while absorbing the aqueous contents of the latter. As the embryo continues to enlarge, numerous starch grains are formed in its cells and grow to considerable size. During the last stages of ripening, proteinaceous storage material (aleurone) fills the vacuoles within

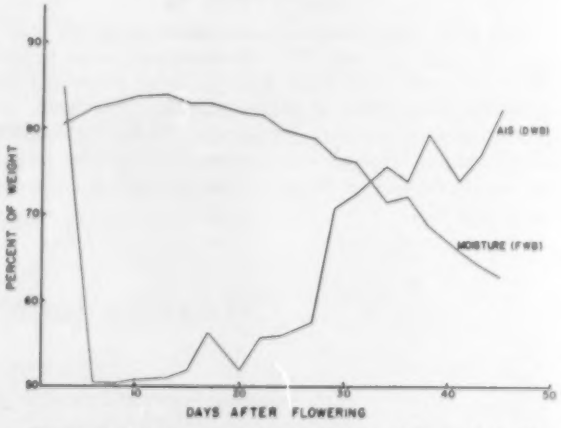

Figure 1. Changes in alcohol-insoluble solids content (dry weight basis) and moisture content (fresh weight basis) during development of the seed of Evergreen lima bean.

the cells of the embryo; and the cell walls become thicker, particularly in the seed coat *(8)*.

Volumetric changes, as is well known, do not parallel the trends of weight changes. Rather, the volume of the seed reaches a maximum about the time of optimum organoleptic maturity and thereafter declines, as the seed shrinks and dries *(2, 4, 5)*. (In this portion of the study, notable shrinkage was just beginning to occur at the conclusion of the sampling.) It becomes apparent, then, that a measure which combines volumetric changes with changes in dry weight could magnify the particularly rapid changes which occur in edible quality at maturation. The combination index chosen was the ratio of dry weight to fresh volume (Table 1). For both varieties of beans, this ratio plotted against moisture content had an identical slope, with a regression coefficient of —0.999.

Another physical index, suggested by Culpepper and Caldwell *(3)*, is the ratio of dry weight of the embryo to the dry weight of the seed coat. As shown in their data, and confirmed histologically, the proportionate amounts of these 2 components of the seed change dramatically in the course of growth. Data of the present study also confirm this change (Table 1). Additionally, the ratio of the fresh weights of these components shows a similar, although less pronounced, trend. It is apparent that the fresh weight ratio of embryo to seed coat could be easily used in the field as an approximate maturity index.

Maturity indices in processed beans. Those suggested measures which change most rapidly during maturation of the seed, viz., moisture content, dry weight/fresh volume ratio, and embryo/seed-coat dry weight ratio, were examined in comparison with the content of alcohol-insoluble solids in frozen lima beans. The results are indicated in Table 2. In this table, moisture percentage and the 2 derivative ratios were determined on the same samples. A. I. S. content was determined on a fresh weight basis on a set of duplicate samples, on which the moisture was also determined.

Computation of the regression coefficients (Table 3) showed that when the A. I. S. content of these frozen samples was taken as a standard for comparison with the other values, the moisture content of the same replicates was the closest index of maturity ($r = -0.990$). Dry weight/fresh volume agreed with A. I. S. to the extent of an "r" value of 0.934. The poorest agreement was found with the embryo/seed coat dry weight ratio ($r = 0.737$). In this latter case, plotting of the curve of this value against A. I. S. (in both raw and processed lima beans) showed a strongly curvilinear trend, which naturally would give a poorer "r" value. It may be recalled that the usual method of computing regression coefficients is based on a *rectilinear* relationship *(6)*.

When the 2 physical ratios were compared with moisture content determined on the same set of samples, closer relationships were found. In the case of dry weight/fresh volume vs. moisture content, the regression coefficient was —0.999. However, there was little difference when embryo/seed coat dry weight was compared with moisture, viz., $r = -0.750$. Hence, despite the uniformity of many Fordhook samples [in the processing variations *(11)*] the ratio of dry weight to fresh volume shows a definitely greater utility than the embryo/seed coat ratio.

TABLE 2
Analysis of physical measurements on frozen lima beans

Sample		1st Sample		2nd Sample		
		A. I. S. (FWB)[1]	Moisture	Moisture	Embryo/seed coat (dry wt.)	Dry weight/fresh volume
		%	%	%		
Clark's Bush	26° —[2]	25.63	69.21	70.15	5.578	0.322
	28°-26°	25.03	68.77	66.36	6.060	0.370
	30°-28°	28.82	66.04	65.35	6.671	0.389
	32°-30°	29.99	64.66	63.88	6.749	0.409
	32° +	32.07	63.67	62.21	7.468	0.430
Wilbur	26° —	16.23	76.97	77.21	3.697	0.245
	28°-26°	20.95	72.45	73.04	4.438	0.298
	30°-28°	23.49	70.36	69.91	5.671	0.332
	32°-30°	26.06	69.17	68.29	6.327	0.352
	32° +	27.44	67.55	66.75	6.963	0.372
Thorogreen	Oct. 16	26.57	69.05	65.79	6.628	0.384
	Oct. 19	27.56	67.53	65.12	6.464	0.395
	Oct. 22	30.63	64.71	63.96	6.960	0.402
	Oct. 25	29.03	66.06	61.08	8.137	0.439
	Oct. 29	27.50	67.69	64.26	6.746	0.402
Henderson Bush	Aug. 28	13.42	82.86	75.19	3.844	0.264
	Aug. 31	21.46	73.74	71.84	4.948	0.308
	Sept. 3	24.68	70.48	68.33	5.850	0.354
	Sept. 6	28.07	67.88	65.40	7.205	0.394
	Sept. 10	31.04	63.71	59.37	9.281	0.461
Evergreen	26° —	23.32	70.28	73.15	3.865	0.290
	28°-26°	26.47	66.62	69.38	5.511	0.338
	30°-28°	23.77	69.48	68.26	5.954	0.357
	32°-30°	26.30	67.17	66.06	6.325	0.384
	32° +	28.21	65.38	62.97	7.481	0.420
Concentrated Fordhook (Mountainview)	18° —	18.90	77.29	66.86	7.415	0.353
	21°-18°	21.25	73.42	72.03	5.876	0.305
	24°-21°	22.30	72.83	70.60	6.134	0.319
	24° +	25.38	69.56	66.45	7.322	0.371
Concentrated Fordhook (Davis)	18° —	12.99	81.11	81.90	3.288	0.191
	21°-18°	15.93	77.38	79.03	4.223	0.225
	24°-21°	21.14	72.31	75.11	5.366	0.272
	24° +	22.51	72.66	72.30	7.125	0.307

[1] Fresh weight basis.
[2] See text for explanation of sample segregation.

TABLE 3
Regression coefficients of physical attributes with alcohol-insoluble solids in duplicate samples of frozen lima beans

Type of bean	Number of samples	Physical attribute (r — value)		
		Moisture %	Embryo/seed coat (dry weight)	Dry weight/fresh volume
Fordhook	37	—0.848	0.638	0.914
Thin-seeded	20	—0.983	0.896	0.895
Baby potato	5	—0.997	0.768	0.762
All	62	—0.990	0.737	0.934

TABLE 4
Regression coefficients of physical attributes with moisture content in same samples of frozen lima beans

Type of bean	Number of samples	Physical attributes (r — value)	
		Embryo/seed coat (dry weight)	Dry weight/fresh volume
Fordhook	37	—0.623	—0.990
Thin-seeded	20	—0.962	—0.998
Baby potato	5	—0.990	—0.999
All	62	—0.750	—0.999

Thus, the dry weight/fresh volume determination, which can readily be ascertained with a minimum of equipment, or the moisture content itself, are credible indices of the physiological maturity of both fresh and frozen lima beans. The former should be tested further.

SUMMARY

A developmental study of raw Henderson Bush and Evergreen lima beans suggested the use of certain physical attributes as indices of physiological maturity. Both moisture content and the ratio: dry weight/fresh volume show a high rectilinear correlation with alcohol-insoluble solids content in both raw and frozen-processed beans. The ratio of embryo/seed coat dry weight has a lower correlation with the alcohol-insoluble solids content, very likely due, among other things, to the curvilinearity of this relationship.

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Amending the Federal Food, Drug, and Cosmetic Act*

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When the invitation to speak at this conference was addressed to me, it was suggested that I should discuss those recently enacted and pending amendments (June 1954) to the Food, Drug, and Cosmetic Law which are of the greatest significance in food technology. Included in this category and perhaps of greatest interest to the food technologist is the problem of chemical additives.

Before expectations are aroused, I must state now that I will not be able to give you any new information or recent decisions on this subject. However, we may review briefly the present applicable sections of the Food, Drug, and Cosmetic Law.

In defining adulteration of foods, the law makes a distinction between substances which may be present naturally and substances which may be added. In the case of a natural substance of poisonous or deleterious character, the present law considers the food containing it as adulterated only if the quantity of the poisonous substance in the food ordinarily renders it injurious to health.

In the case of poisonous or deleterious substances which are added, the presence of any amount is prohibited unless the added substance is required in the production of the food or cannot be avoided by good manufacturing practice. In such cases the Secretary of the Department of Health, Education, and Welfare is authorized to promulgate tolerances limiting the amounts of deleterious substance to the extent necessary for the protection of the public health. In determining such tolerances, the Secretary must take into account, not only the extent to which use of the substance may be required or cannot be avoided in production, but also other ways in which the consumer may be affected by the same or other poisonous or deleterious substance.

The problem in any such tolerance-making procedure reduces itself essentially to two fundamental questions: namely, how necessary is the substance? and how much of it may be permitted without endangering the public health? For example, in the case of the agricultural chemicals the question of need for arresting the ravages of insects and bringing crops to maturity for the use of man may be relatively easier to establish than could be done with respect to the formidable array of antioxidants, stabilizers, plasticizers, preservatives, inhibitors, softeners, emulsifiers, flavors, and a host of other types of "improvers" that are constantly being developed and exploited for use in foods.

Maximum and minimum safety. Having determined the necessity, the establishment of the maximum safe limit would have to take into consideration the intake from other sources, the effects of different combinations and synergistic variations and the diverse uses, let us

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say, of the same ingredient in different types of foods, all of which would affect the cumulative total of poison reaching the consumer.

The question of what constitutes a minimum procedure in judging the safety of a new chemical additive is very important. Such a minimum, to be of value, should, we believe, cover at least the following basic points:

1. The chemical identity of the additive should be definitely established and analytical methods should be available for its detection, identification, and quantitative estimation.

2. There should be comprehensive data as to the acute toxicity levels in test animals which should not be limited to the rodent species but should include also one or more non-rodent species.

3. There should be comprehensive studies of the sub-acute and chronic toxicity effects in test animals including not only growth, mortality, and reproduction patterns but also blood level studies, metabolic fate of the compound, examination of organs and tissues and similar criteria.

How these studies should be conducted, whether the industry or the Government should finance them, who should be the final judge of their adequacy, and what legal safeguards should be set up to insure compliance with the chosen course are among the controversial questions that are being studied in connection with new legislation.

Pesticide chemicals. Closely related to chemical additives is the problem of pesticide chemicals. A bill, H. R. 7125, entitled "An Act to Amend the Federal Food, Drug, and Cosmetic Act with Respect to Residues of Pesticide Chemicals in or on Raw Agricultural Commodities" was introduced [b] by Representative A. L. Miller of Nebraska.

The procedures regarding pesticide chemicals set up in this bill may be briefly summarized as follows: Any person who has applied for registration of an economic poison under the Federal Insecticide, Fungicide, and Rodenticide Act may initiate a regulation to establish a tolerance by requesting the Secretary of the Department of Agriculture to certify to the usefulness of the proposed pesticide and by requesting the Secretary of the Department of Health, Education, and Welfare to establish a tolerance. The petition for a tolerance must include information regarding the identification of the chemical, its method of application, full reports on safety investigations, results of tests made on residues, analytical methods, practical methods for removal of the residue, and a proposed tolerance together with grounds for support of the petition. The Secretary, after studying the data, may either establish a tolerance or exempt the chemical pesticide from the need for a tolerance. Any tolerance must limit the pesticide chemical residue to the extent necessary to protect the public health, and the bill specifically states that the tolerance may be set at zero, thus prohibiting the use of the pesticide where data on its safety so justifies.

Either the Secretary on his own initiative or at the request of the applicant for tolerance may refer the data to a committee to evaluate the safety of the product, and the final tolerance or exemption will be determined from the report of this committee together with other available data.

The bill sets up time limits to insure the orderly handling of the various reviews and to prevent delays. There is also provision made for formal court hearings in the event the informal procedures described above do not settle the tolerance to the satisfaction of the parties. In the event of a controversy, court proceedings may be instituted by any party who is adversely affected by any order issuing from the Secretary establishing a tolerance or an exemption.

The Secretary of the Department of Health, Education, and Welfare may also initiate a regulation to establish a tolerance or an exemption. The procedures are somewhat different, but the same rights of review by an advisory committee of scientific experts and by the Courts remain to any parties adversely affected.

The advantages of this Amendment are these: The Secretary of the Department of Agriculture resolves the problem of usefulness of the chemical pesticide on raw agricultural commodities. This eliminates the need for court adjudication, whether the given pesticide chemical is "required in production or cannot be avoided by good manufacturing practice." The person proposing a tolerance for a pesticide residue must assume the burden of establishing safety from the standpoint of the consumer, and provision is made for review of the data pertaining to safety by a committee of disinterested experts. Informal proceedings may be used to clarify controversial issues so that the scope of formal public hearings and court review is limited only to those issues on which disagreement exists, whereas under the present law, all issues must be heard in public hearings. Provision is made for exemptions where no tolerance is necessary for public protection and for temporary tolerances under experimental permits.

Food standards. The Hale Amendment to the Food, Drug, and Cosmetic Act became law on April 15, 1954. This Amendment simplifies the procedures for establishing food standards. It provides that the Secretary on his own initiative or any interested party may propose the issuance, amendment, or repeal of any regulation pertaining to food standards. After the proposal has been published, all interested parties are given an opportunity to present their views orally or in writing. Thirty days are then allowed for the filing of objections to the order by anyone adversely affected thereby. If no objections are filed, the order becomes effective after thirty days. If objections are filed, they must specify the provisions of the order which are objectionable and the grounds therefor. This filing of objections stays the effectiveness of the provisions of the order to which objection is taken pending final action by the Secretary.

A public hearing is then held for taking of testimony on the issues in controversy, after which a final order is issued based only on evidence of record presented at the hearing. This order is subject to review by the Courts as were the food standards promulgated before the Amendment became law.

[b] Subsequent to the presentation of this paper in June, 1954, the bill was adopted (2nd Session, 83rd Congress), signed by the President on 22 July 1954, and became Public Law 518. It is to become fully effective on 22 July 1955.

The two most significant changes compared to the provisions of the law prior to the Amendment are: first, any individual showing reasonable grounds may petition for a food standard regulation, whereas formerly such petition must originate on the application of an industry or a substantial portion thereof. Secondly, the public hearing will be limited to issues in controversy, where previously the entire standard had to be supported by evidence presented at a public hearing.

This Amendment eliminates the waste of time and funds by both industry and Government that previously was necessary to support proposals that everyone agreed with and to provide facts that everyone knew. At the same time, the Amendment guarantees an opportunity for a hearing to all who are adversely affected and preserves all of the safeguards of court review. This Amendment was sponsored by the Food, Drug, and Cosmetic Law section of the New York State Bar Association and was supported by industry and Government alike. It is an excellent example of progress and improvement that can be made by cooperation and understanding between those who are regulated by the law and those who enforce it.

Factory inspection. The Factory-Inspection Amendment to the Food, Drug, and Cosmetic Law is now over a year old. Many issues in that Amendment were highly controversial. Some comment on factory inspections under this Amendment may be in order. The law provides that inspections of factories and other establishments are authorized upon presentation of credentials and a written notice to the owner, operator, or agent in charge. The inspector is required to give to the owner, operator, or agent in charge a written report setting forth any conditions or practices observed by him which in his judgment indicate that any food, drug, device, or cosmetic in such establishment either consists in whole or in part of any filthy, putrid, or decomposed substance or has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth or rendered injurious to health. He must also give a receipt for any samples obtained, and if any such samples are analyzed to determine if they consist in whole or in part of any filthy, putrid, or decomposed substance or are otherwise unfit for food, a copy of the results of that analysis must be furnished promptly to the owner, operator, or agent in charge.

Since the Amendment became law, factory inspections have proceeded with little change in attitude on the part of the industry. The legislative history of the Amendment exempts industry from any legal obligation to make available certain information which is often requested by inspectors during factory inspection. The number of refusals to permit access to this information and data is somewhat greater than before the Amendment became law, but for the most part, the cooperation that has characterized relations between the Food and Drug Administration in the field and the regulated industries still continues.

The provision of the Factory Inspection Amendment that the inspector shall give a written statement regarding objectionable conditions which he observes is particularly significant. Formerly, when insanitary conditions which were likely to result in contamination of the finished product were observed in a factory, these were described by the inspector in his report and in keeping with common practice, he verbally reported the objectionable conditions to a responsible officer of the firm. Later, seizure or citation has brought representatives of the firm to the Food and Drug office for discussion. Often when this occurs these representatives state that they were never told by the inspector of his observations of insanitary conditions, and they did not know that any objectionable practices existed in their factory. We are confronted on the one hand by the inspector's report including perhaps two or three pages describing insanitary conditions and his statement that he told a representative of the firm of his observations, and on the other hand by the denial that any officer of the factory was ever told about these conditions. It is difficult to reconcile these two contradictory statements and distasteful to conclude that one or the other is misrepresenting the facts. Further inquiry in these situations sometimes brings out that the person warned by the inspector is not the same one who calls at the Food and Drug office and that the former never communicated the inspector's observations to his superior officers. They therefore are uninformed as to the inspector's findings.

Where the same individual representing the firm is involved in both instances, it is perhaps proper to conclude that the inspector for one reason or another did not get his message across and the person he talked to at the factory was not convinced that conditions in the plant were objectionable. The written statement of objectionable conditions now prepared by the inspector before he leaves the plant will go a long way toward eliminating such difficulties. The inspector in preparing a written description of insanitary and other objectionable conditions in the presence of the operator of the plant will unquestionably be precisely accurate in listing his observations. The person to whom the report is given will have no grounds to deny receiving it. The inspector's observations in a factory are of great importance in determining whether seizure or prosecution will result from the inspection. Any procedure that will provide a better understanding on this score is certainly desirable in the interests of both parties.

A CALCULATED EFFORT TO FIND COMMON GROUND

The above is a rather limited summary of the status of pending legislation (as of June 1954) and the effects of recently enacted legislation of importance to the food industry. This is a period of great progress in the technology of foods and food production. We cannot anticipate all of the needs and problems that may arise from the rapid changes made. It is significant that the Food, Drug, and Cosmetic Law is not an immovable object and that it can be modified when circumstances make this desirable or necessary. It is doubly significant that when amendments to the law are under consideration, there is no division between industry and Government into two hostile camps categorically opposing each other's views, but instead there is a calculated effort to find common ground for agreement and understanding so that the legislative problem of resolving differences is reduced to a minimum.

Freeze-Dried Meat. I. Preparation and Properties[a,b]

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Pieces of beef have been successfully dehydrated by freeze-drying. The rate of freeze-drying is low because of the low thermal conductivity of the dried meat. The resulting freeze-dried beef is pink in color and very porous in structure. It rehydrates readily to give a product having all the essential properties of fresh meat.

Observations on the freeze-drying of serving-size pieces of a wide variety of meat, fish, and poultry are reported.

Dehydrated meats with good storage stability and high acceptability after rehydration and cooking are needed by the military and would have many civilian uses. Production of dehydrated meat for military feeding reached large proportions during the second world war. The production and properties of the dehydrated meat items made of ground cooked beef and pork dried at relatively high temperatures have been adequately described by the English and American researchers *(1, 8, 12)*.

These dehydrated meat items have several severe disadvantages. The ways of serving ground precooked meat are very limited. Meat is most acceptable in the form of serving-size steaks, chops, roasts, and large pieces of stewing meat in which its physical structure is maintained. Ground meat is immediately limited to soups, stews, and patties. Dehydration at relatively high temperatures because of protein denaturation and browning has an adverse effect on the quality of the meats. Thus, immediately after production, meats dehydrated at elevated temperatures have a low acceptability rating.

The ideal dehydrated meat on the basis of acceptability criteria would be one which after rehydration and cooking would have all the essential physical and organoleptic properties of freshly cooked meat.

Since the characteristic flavor of meat is developed during cooking and since meat is usually served hot, it is desirable to reserve the cooking process until the time of desired consumption. This does not eliminate the possibilities of using partially cooked meat for dehydration. Though the "ready to eat" meat bars are not considered directly here, the same problems of obtaining acceptable products apply.

Considering the methods of dehydration, only freeze-drying has been successfully applied to the drying of heat-labile biological materials with minimal physical and chemical changes. Relative to physical structure, freeze-drying does not destroy the submicroscopic structures of bacteria, viruses, tissue slices, etc. *(4, 6)* and thus appears ideally suited for drying meat with minimum histological changes. Moreover, freeze-drying has been applied successfully to drying blood plasma, enzymes, viruses, bacteria, etc. *(4, 6)* without protein denaturation in these very labile materials. Thus, freeze-drying can be considered the logical method for drying meats without the concurrent chemical changes, especially those of protein denaturation, which cause the failure of high temperature drying of meats.

The possibilities of using freeze-drying for the commercial production of dehydrated meat was suggested as early as 1945 by Flosdorf *(3)*. Until the present time, serious consideration was not given to commercial freeze-drying of meat because of the presumed high unit cost. However, it should be emphasized that neither engineering development studies nor detailed cost estimates on commercial freeze-drying of meat have been reported. Estimates of the overall cost range from $0.03 to $0.30 per pound of water removed. Among the various dehydrated food products whose commercial production by freeze-drying has been suggested dehydrated meat appears most economically favorable. Meat in serving-size pieces cannot be successfully dehydrated by any other known means whereas the other foods can. Meat is already a high unit cost item and freeze-drying costs *per se* will probably represent only a small fraction of the total cost of the dehydrated meat *(4)*.

It is the purpose of this research to study the preparation, the food properties, and the storage stability of freeze-dried meat. This paper describes the freeze-drying and resulting properties of one-inch thick pieces of beef *Biceps femoris* and various serving-size pieces of meat, fish, and poultry.

EXPERIMENTAL

Materials. The *Biceps femoris* muscle of beef animals was selected as the raw material because it is a large muscle easily obtained from wholesale cuts, its physical and chemical properties are about average for beef muscles and have been studied extensively *(11, 13)*. The *Biceps femoris* muscles were dissected from hindquarters of steer beef (1000 lb. class), fattened in feed lots, aged at 34° F. for 2 weeks, and graded U.S.D.A. *Choice*.

Each muscle was cut into pieces one inch thick and 2 inches square. Random samples of each muscle were used for the experiments and a sample of each muscle was held at 0° F. as a control.

Serving-size pieces of meats, fish, and poultry were obtained from retail and wholesale sources. Frozen controls were kept for each sample subjected to organoleptic evaluations.

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[c] Present address: Baxter Warehouse Service, Oakland, California.

[d] Present address: Gerber Products Co., Oakland, California.

Drying equipment. Freeze-dryers equipped with infra-red radiant heating and heated hollow shelves were used. The freeze-dryer supplied with infra-red heaters held 15 lbs. of *Biceps femoris* on 3 plastic-bottom trays. These plastic trays had high transmission of radiation in the wavelength range of 2 to 8 microns. Infra-red radiation of the desired characteristics was obtained from microme wires under the trays by supplying current at constant amperage. Heat input was controlled manually. Temperature of the meat was measured with thermocouples wired to a potentiometer. The freeze-dryer was maintained at 0.1 to 0.2 mm. absolute pressure by a positive displacement vacuum pump in series with a condenser at —40° F.

The freeze-dryer equipped with heated shelves consisted of a Stokes vacuum cabinet having a capacity of about 240 lbs. of one-inch thick beef pieces. However, in this study 25 pounds of *Biceps femoris* were freeze-dried. Heat was supplied by warm water circulated through the hollow shelves and was controlled automatically. The temperatures were recorded automatically through thermocouples imbedded in the meat by a 12-point potentiometer temperature recorder. An absolute pressure of 0.6 to 0.7 mm. was maintained by a 3-stage steam ejector.

Serving-size pieces of meat, fish, and poultry were freeze-dried in a Stokes model 2004L freeze-dryer. In this freeze-dryer, heat was supplied by warm water circulated through hollow shelves. The absolute pressure was maintained at 0.1 to 0.2 mm. by a positive displacement vacuum pump and a condenser at —30° F.

Vacuum drying at pressures of less than 23 mm. was accomplished by using a small vacuum oven equipped with a hollow shelf for circulating heat transfer fluid.

Analytical methods. The water content of freeze-dried beef was determined on samples ground in a Wiley mill to No. 10 mesh by the loss in weight after holding in a vacuum desiccator over magnesium perchlorate at room temperature until constant weight was reached (usually 10 days). The vapor pressure of freeze-dried *Biceps femoris* was measured using the apparatus of Legault *et al. (10)*.

Reflectance spectra were measured with an American Optical Company rapid scanning spectrophotometer. Tristimulus values for color were determined from measurements with a Colormaster Differential Colorimeter.

Rehydration expressed as percent of initial water content was determined from the weight gain after submerging the freeze-dried beef in water. After rehydration, the beef was seared in hot fat and then cooked in a pressure cooker at 10 lbs./in.^{2} for 10 minutes prior to organoleptic evaluation. The organoleptic observations reported are based on the scoring and comments of a panel of 7 experienced tasters. Quantitative organoleptic evaluation will be reported later.

FREEZE-DRYING OF BICEPS FEMORIS

Since vacuum dehydration of one-inch thick beef has not been recorded in the literature, pieces of *Biceps femoris* were dehydrated at temperatures of 32-59° F. (0-15° C.) and 86-113° F. (30-45° C.) and absolute pressures less than 23 mm. and the properties of the resulting dehydrated beef were studied. Dehydration at either the low or the high temperature resulted in extensive "case-hardening" of the beef pieces. This "case-hardening" was caused by a denaturation of the surface protein and an accumulation of dry soluble components which were translocated to the surface. Table 1 shows that the drying times were very long and that the organoleptic properties of the beef pieces were poor. This study shows that the theoretical engineering advantage of more rapid heat transfer at temperatures above freezing cannot be realized because protein denaturation at the surface limits the outward diffusion of water.

TABLE 1
Vacuum dehydration of one-inch thick Biceps femoris

Plate temperature	Time in vacuum oven	Final water content	Rehydration 1 hour	Organoleptic observations		
				Color	Texture	Flavor
	hr.	%	%			
0-15° C.	60	20	30	dark brown	dry	roasted
30-45° C.	65	7.5	30	dark brown	dry and stringy	browned

In contrast to vacuum dehydration, the freeze-drying of one-inch thick pieces of *Biceps femoris* can be completed in a shorter time and produces a very superior product. After a preliminary evaluation of the freeze-drying process, relatively large amounts of *Biceps femoris* were freeze-dried using 2 methods of supplying the heat of sublimation. Figure 1 shows the weight loss, meat temperature, and heat input as a function of the drying time when infra-red heating was used. Comparable data for the freeze-drying of pieces of *Biceps femoris* using a conventional heated-shelf vacuum chamber are shown in Figure 2. Considering the higher initial cost and the higher operating cost for supplying heat by infra-red radiation, this method has many apparent disadvantages in comparison to the more conventionally used heated shelves. Heating with infra-red radiation was difficult to control and localized overheating was a problem. Use of either method of heating

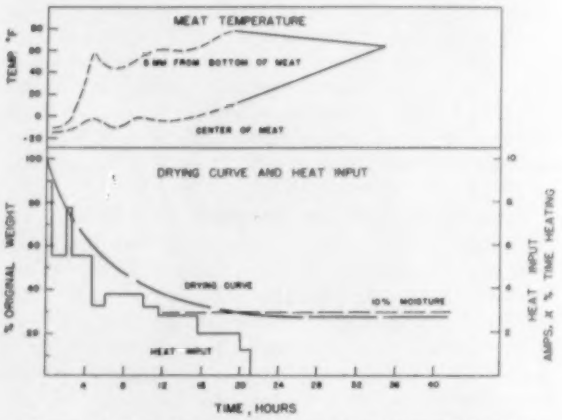

Figure 1. Pilot freeze-drying run using infra-red heating.

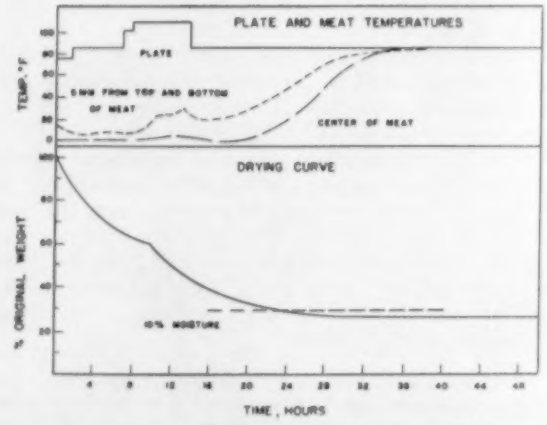

Figure 2. Pilot freeze-drying run using conventional plate freeze-dryer.

resulted in approximately the same drying time of 24 hours to 10% water. These rates of freeze-drying can be increased by maintaining the sample temperature closer to the freezing point and this would have considerable advantage for commercial production.

The cost of commercially produced freeze-dried meat will largely depend upon the length of time the freeze-drying equipment must be operated to complete a drying cycle. The time of drying may be determined either by the maximum rate of flow of the water vapor out of the meat pieces or by the maximum rate of supplying the heat of sublimation or both. The thermal conductivity of *Biceps femoris* ranges from about 1.3 B.T.U./(hr.) (ft.) (° F.) for the frozen meat at the beginning of drying to about 0.02 B.T.U./(hr.) (ft.) (° F.) when the meat is dry.

At the very beginning of freeze-drying, the side of the meat blocks nearest the heat source dries rapidly. As the ice phase boundary regresses away from the heat source, heat transfer through the dried layer of meat becomes difficult because of the low thermal conductivity of 0.02 B.T.U./(hr.) (ft.) (° F.). Because of the high thermal conductivity of the frozen meat relative to the low thermal conductivity of dried layer, the temperature throughout the frozen meat core is essentially uniform. The result on drying of the uniform temperature of the frozen meat is illustrated by a study of the regression of the ice phase boundary during freeze-drying using infra-red radiation to supply the heat of sublimation. Figure 3 shows that except for the initial rapid drying at the bottom nearest the heat source, the ice phase boundary regressed in a symmetrical pattern.

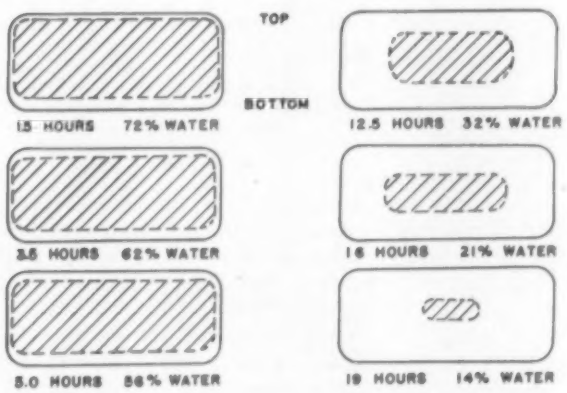
TOP
BOTTOM
1.5 HOURS 72% WATER
12.5 HOURS 32% WATER
3.5 HOURS 62% WATER
16 HOURS 21% WATER
5.0 HOURS 56% WATER
19 HOURS 14% WATER
SECTIONS WERE MADE DURING A PILOT RUN USING INFRA-RED HEATING

Figure 3. Cross section of meat chunks showing regression of ice phase during freeze-drying.

PROPERTIES OF FREEZE-DRIED BICEPS FEMORIS

The properties of freeze-dried *Biceps femoris* are listed in Table 2. Further characterization of the color of the freeze-dried and rehydrated beef is given by the reflectance spectra shown in Figure 4. The pink color, characterized by its brightness and high spectral reflectance, is one of the unusual properties of freeze-dried beef. The balsa woodlike physical structure accounts for the very low thermal conductivity. At the low oxygen tensions in the freeze-dryer, oxymyoglobin is deoxygenated to myoglobin. Free myoglobin is responsible for the pink color of freeze-dried meats and is labile to oxidation during storage and rehydration. Oxygenation of the myoglobin during rehydration is best accomplished in an oxygen atmosphere.

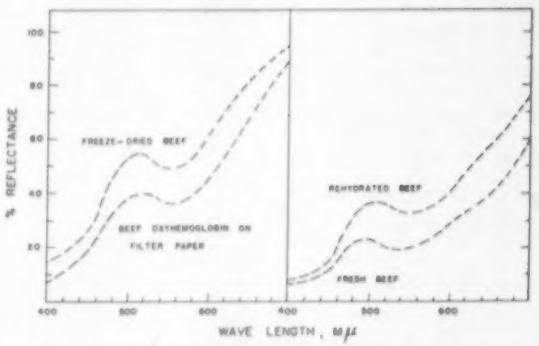

Figure 4. Reflectance spectra of freeze-dried beef.

TABLE 2
Properties of freeze-dried Biceps femoris

Moisture content	3% after 24 hours in freeze-dryer
Structure	Like balsa wood. No volume change during freeze-drying
Color	Pink
Tristimulus Values	
Brightness	14-17%
Dominant Wavelength	591-592 mμ
Excitation Purity	29-32%
Rehydration 1 hour	80-90%
Organoleptic Observations	
Flavor	Same as frozen control
Texture	Generally drier than control
Appearance	Same as frozen control

The rate of rehydration is primarily dependent upon the rate of flow of water through the capillary-like openings into the central portion of the blocks of meat. Rehydration of the meat proteins *per se* takes place very rapidly. Rehydration of whole beef pieces becomes rapid (<5 min.) when the air is completely evacuated from the dried beef. The level of rehydration of freeze-dried *Biceps femoris* is high and it can be increased by evacuation of the air from the dried beef, however, after cooking the texture is usually more dry than the controls indicating less tenacious binding of the water.

The relation between the water vapor pressure and the water content of freeze-dried *Biceps femoris* is shown in Figure 5. Three samples of *Biceps femoris* from different animals showed no essential differences on a dry fat-free basis. Knowledge of this relation is very useful in determining water content of freeze-dried beef by measuring the vapor pressure, in choosing operating conditions for commercial freeze-drying, and in predicting the applicability of in-package desiccation. Ordinarily manometric measurement of the vapor pressure of freeze dried meat can be easily accomplished and requires 3 hours, whereas, an accurate measure of the water content by the vacuum desiccator method requires two analytical weighings and a holding period of approximately 10 days in the vacuum desiccator.

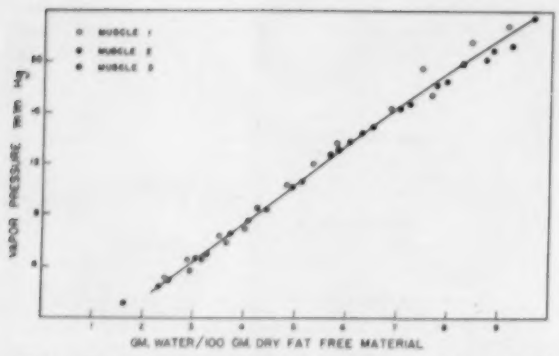

Figure 3. Vapor pressure—moisture content of freeze-dried beef. Temperature 100° F.

The fact that vapor below 2 g. water/100 g. dry fat-free beef is not very much greater than the usual operating pressures of commercial sized freeze-dryers, i.e. 0.5 to 1.0 mm. predicts the difficulties of removing water below this level by conventional freeze-drying. A more economic practice for the attainment of the low moisture contents necessary for good storage stability consists in freeze-drying supplemented with the use of in-package desiccation *(7, 9)*.

Many comparisons of the organoleptic properties of freeze-dried *Biceps femoris* after rehydration and cooking with the cooked frozen control indicated that in flavor and appearance the freeze-dried beef was not essentially different. A characteristic property of the freeze-dried beef has been its drier texture. This problem has not yet been resolved.

FREEZE-DRYING OF SERVING-SIZE PIECES OF MEAT, FISH, AND POULTRY

Freeze-drying appears to be the only practical method for the production of high quality serving-size pieces of dehydrated meat, fish and poultry. Based on the successful application of freeze-drying to the preparation of one-inch thick *Biceps femoris*, use of this method of dehydrating has been extended to the dehydration of a wide variety of meat, fish, and poultry. Table 3 summarizes results of studies on the relative rates of freeze-drying.

The drying times recorded in Table 3 were determined from individual graphs of the drying curves. These studies of the freeze-drying rates of this wide variety of animal products led to the following observations. Those products which have relatively impermeable surface layers require excessively long drying times unless the surface layer is removed or physically perforated. Good examples are: the skin of beef tongue, chicken, and mackerel; the fat of beef heart and kidney; and the gelatinous surface of wieners. During the terminal phase of the freeze-drying of chicken and pork products heated shelf temperatures should be below 35° C. to prevent the melting of fat.

Since the main emphasis here was on the production of dehydrated meat, fish, and poultry of high quality, the relative drying times shown do not represent minimum drying times which might be achieved under commercial production conditions. Because of the relatively high cost of freeze-drying equipment initially and of operating at high vacuum, economic commercial production will involve drying at maximum rates. For any given piece of equipment and food product the maximum drying rate will be determined by the two variables, the total pressure in the vacuum chamber and the temperature of the food. At present, studies are being directed toward the development of basic engineering equations and the design of equipment for commercial freeze-drying of meat *(5)*.

Freeze drying has long been considered the best means of dehydrating meats without losses in quality

TABLE 3

Freeze-drying of serving-size pieces of meat, fish, and poultry

Food	Thickness	Plate temperature	Pressure	Drying time
	inch	*° C.*	*m.m.*	*hours*
Beef shoulder steaks	¾	45	0.10	19
Beef cube steaks	¾	45	0.10	12
Pork steaks	½	45	0.10	12
Lamb shoulder chops	½	45	0.10	10
Veal shoulder chops	½	45	0.10	16
Beef T-bone steaks	1	45	0.15	>22
Beef rib steaks	¾	45	0.15	20
Beef round steaks	1	45	0.15	>22
Pork chops	½	45	0.15	18
Pork steaks	½	45	0.15	16
Lamb chops	½	45	0.15	16
Beef heart	2	40	0.09	>52
Beef tongue	1¾	40	0.09	>52
Beef spleen	1	40	2	48
Beef kidney	2	40	2	48
Beef brain	1½	40	2	48
Lamb heart	1½	40	2	27
Lamb liver	1¾	40	2	23
Beef round steaks	1	42	0.20	20
Pork chops	½	42	0.20	12
Lamb chops	½	42	0.20	10
Smoked ham slices	½	49	0.08	15
Skinless wieners	1	49	0.08	15
Luncheon meats				
Boiled ham	3/32	49	0.08	7
Bologna	⅛	49	0.08	7
Salami	⅛	49	0.08	7
Variety loaves[1]	⅛	49	0.08	7
Mackerel (whole)	1	37	0.09	>33
Halibut steaks	1	37	0.09	25
Salmon steaks	1	37	0.09	25
Sea bass steak	1	37	0.09	25
Sole fillets	½	37	0.09	17
Crabmeat (cooked pieces)	½	37	0.09	13
Chicken breast	1	35	0.07	36
Chicken legs	1	35	0.07	36
Chicken thighs	1	35	0.07	36

[1] Three different beef-pork mixtures.

(3, 4). In many studies of meat dehydration, freeze-dried meat was used as a standard of perfection for comparative purposes. Organoleptic evaluations of quality after rehydration and cooking were made on most of the products listed in Table 3. The general observations were similar to those made on freeze-dried *Biceps femoris*. The freeze-dried food could usually be differentiated from the frozen control and usually had a more dry texture. However, if served without a control for direct comparison the freeze-dried product would probably be highly acceptable to the average consumer.

An exception to this general observation was the insipid taste of luncheon meats which had undergone freeze-drying and subsequent rehydration. The loss of

the flavor of the spices of luncheon meats was caused by its volatilization during freeze-drying.

These studies illustrate the general applicability of the freeze-drying process to the production of high quality serving-size pieces of dehydrated meats, fish, and poultry.

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Antibiotics in Animal Nutrition

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The use of antibiotics to increase growth in a number of species of animals is examined. Studies on the mechanism of their action are reviewed including the vitamin sparing action and the inhibition of harmful bacteria in the intestinal tract. The clinical effects of continuous administration of antibiotics are also summarized.

The finding that small amounts of antibiotics increase the growth of animals has stimulated research on the function of the intestinal microflora. The ability of these bacteria to synthesize vitamins within the intestinal tract is well established. This is based largely on the observation that the administration of bacterial antiseptics such as sulfonamides to animals maintained on diets containing suboptimum amounts of certain vitamins may accentuate a vitamin deficiency *(15)*. In the presence of an adequate dietary source of these vitamins, antibacterial agents such as succinylsulfathiazole do not depress growth but may sometimes produce a definite growth increase *(24)*. The finding that the antibiotics may have a utilitarian value in increasing growth of animals was the result of a separate series of observations on the production of vitamin B_{12} during the fermentation-production of chlortetracycline. Chlortetracycline fermentation products were found to produce growth responses in chicks *(33)*, turkeys *(34)* and pigs *(19)* even when adequate amounts of vitamin B_{12} were included in the basal diet.

A few observations may be made regarding the nature of the antibiotic growth response. The quantities of antibiotics used are much smaller than those normally administered to achieve a therapeutic effect. The magnitude of the response varies with diet, species and environment. With chicks, growth increases between 0 and 30% have been observed at 4 weeks of age. Under field conditions the average response may be between 3 and 10% at 8 to 10 weeks of age. The response with turkeys is usually larger than with chicks. The most striking increases produced by antibiotics have been observed in pigs. In this case the response is markedly affected by the environment as well as the diet. Growth responses of 100% over the control have been observed. In some of these experiments where antibiotics have given very large responses, diarrhea and enteritis were present, and the increase in growth was due to combined nutritional and therapeutic effects.

Antibiotics may be considered to function by permitting the normal growth of an animal. As an example of this one may cite the effect of antibiotics on "runt" or "slow-gaining" pigs. These are animals which grow slower than their litter mates but which exhibit no specific pathological symptoms. These animals which fail to grow at a normal rate on a nutritionally adequate diet may give striking growth increases upon the administration of an antibiotic. This is shown in the experiments reported by Becker *et al. (3)*, Table 1, in

which the "slow-gaining" pigs on the control diet gained 0.55 lbs. per day while those receiving chlortetracycline gained 1.63 lbs. per day. These observations indicate that the slow growth of runt pigs is not necessarily a genetic quality or a simple nutritional deficiency but

TABLE 1
Results of feeding chlortetracycline to slow-gaining pigs (Becker et al., 3)

	No chlortetracycline	5 mg. chlortetracycline per lb. feed
Initial Wt., lbs.	48.4	46.8
Final Wt., lbs.	67.8	100.
Daily Gain, lbs.	0.55	1.65
Feed per lb. gain, lbs.	4.75	2.88

Basal Diet: soybean meal, corn, minerals and vitamins including vitamin B_{12}.

rather the consequence of deleterious intestinal microflora. Similar observations have been made with turkeys *(32)*.

Antibiotics might be expected to have a different effect on ruminants whose nutrition is basically dependent on bacterial synthesis. When large amounts of antibiotics are given to ruminating animals such as steers *(4)*, there may be a temporary anorexia and gastrointestinal disturbances. However, administration of small amounts, 15 to 100 mg. per day, of chlortetracycline to young calves which have not yet begun to ruminate increases the growth rate, decreases diarrhea, and improves the physical appearance of the animal *(1, 28)*. The magnitude of the growth increases in calves has varied from 7 to as high as 70% while most increases are in the order of 15 to 30% above the controls. In these instances where very large increases were observed the growth on the unsupplemented control were lower than normal. When antibiotic feeding is initiated at an early age, it may be continued until after the animal reaches maturity without any evidence of digestive disturbance *(16)*. Antibiotics have also been reported to give growth increases in rats *(25)*, mice *(37)* and rabbits *(20)*.

MECHANISM OF ACTION

The action of antibiotics in increasing growth apparently is confined to their effect on the microorganisms within the intestinal tract. This is based largely on the following observations:

1. Antibiotics of widely varying structure are effective in promoting growth. This precludes the possibility of their being used within the body as precursors of a metabolite.
2. Antibiotics produce no effect in germ-free animals *(23)*, and in the developing chick embryo *(35)*.

A great deal of effort has been directed toward an elucidation of the mechanism of action. It has become apparent that no single mechanism is responsible and that antibiotics may function in different ways under different conditions. The three principal mechanisms that have been postulated to account for the action of antibiotics are:

1. Enhancement of vitamin synthesis within the intestinal tract.
2. Inhibition of bacteria which absorb dietary factors and prevent utilization by the host.
3. Elimination of harmful bacteria.

Vitamin sparing action of antibiotics. There is abundant evidence that antibiotics may increase bacterial synthesis of vitamins in the intestinal tract. This increased vitamin synthesis, however, cannot account for the growth response observed on diets adequate in the known vitamins. Although the feeding of certain sulfonamides do decrease the intestinal synthesis of vitamins, there is no evidence that this happens with the antibiotics which give a nutritional growth response. The thiamine sparing action of antibiotics shown is evident from the experiments of Lih and Bauman *(22)* which are presented in Table 2. These results show that penicillin gives a growth response on a thiamine-free diet as well as on a diet containing a suboptimum amount of thiamine (1.0 mg./kg.). Different antibiotics vary in their thiamine sparing effect, penicillin being the most effective and chloromycetin the least. It will be noted that although chlortetracycline did not give an appreciable growth increase on a thiamine-free diet, it did markedly reduce the mortality. Similar results observed with other vitamin deficiencies suggest that the mortality occurring on highly deficient diets may be partly the result of bacterial invasion which is minimized by antibiotic feeding.

Chlortetracycline has been reported to have a sparing effect on the folic acid requirement of the chick *(5)* while penicillin had no effect on the requirements of the chick for riboflavin, pyridoxine and pantothenic acid *(12)*. Rats have been maintained on pantothenic or riboflavin deficient diets for as long as a year by the addition of either 20 p.p.m. of chlortetracycline or 2% of ascorbic acid *(14)*. Antibiotics may reduce the vitamin B_{12} requirements under certain conditions but the effect is not consistently observed in all experiments *(36)*. However, in those cases where there was no effect on the vitamin B_{12} requirement, chlortetracycline markedly reduced the mortality on the highly

TABLE 2
Effect of certain antibiotics on growth and survival of rats fed limiting amounts of thiamine (Lih and Bauman, 22)

Thiamine, Mg./Kg. Diet	Av. Wt. 4 Wk., Gm.	Antibiotic/Kg. Diet
0	40 (1/5)[1]	0
0	50 (4/5)	50 mg., chlortetracycline
0	64	50 mg., penicillin
1.0	102	0
1.0	102	50 mg., chlortetracycline
1.0	125	50 mg., streptomycin
1.0	151	50 mg., penicillin
1.0	83	50 mg., chloromycetin
1.0	101	50 mg., oxytetracycline
1.0	122	10 gm., sulfasuxidine
2.0	143	

[1] Number in parentheses indicate survivors.

deficient diets. This is similar to the effect of chlortetracycline in reducing mortality of rats on thiamine-free diets even though there was no evidence of a thiamine sparing effect at suboptimal thiamine levels *(22)*.

Antibiotics increase the bacterial synthesis of vitamin B_{12} in the intestine but the vitamin so produced does not appear to be always available to the animal. The feeding of chlortetracycline to rats increased the amount of vitamin B_{12} in the cecum and the colon but not in the ileum. The absence of any increase in the vitamin B_{12} content of the liver and kidneys indicated the vitamin B_{12} formed by bacterial synthesis was not absorbed. The feeding of small amounts of vitamin B_{12} increased the concentration of this vitamin in the ileum but not in that of the cecum or colon. There was also a marked increase in the vitamin B_{12} content of the liver and kidney which showed the ready availability of orally ingested vitamin B_{12} to the animal *(26)*.

By the use of radioactive cobalt it was also shown that chlortetracycline increases the intestinal synthesis of vitamin B_{12} three to eight times, but examination of the tissues indicated that none of the radioactive vitamin B_{12} had been utilized *(10)*.

Chlortetracycline and a combination of antibiotics have been found to give a hematological response in pernicious anemia *(21)*. This response could have been due to an increased synthesis of either vitamin B_{12} or folic acid as either of these vitamins produces the same hematological effect.

Antibiotics have an effect on liver and kidney lesions which have been induced by dietary procedures. Rats which have been

maintained on high yeast diets develop a liver necrosis which can be prevented by the feeding of methionine or vitamin E. This necrosis can be decreased and delayed, but not completely prevented, by feeding of 25 mg. of chlortetracycline per day, Table 3 *(17)*. Antibiotics have been found effective in the prevention of renal damage induced in rats by feeding of low choline diets containing large amounts of fat, Table 4 *(2)*. This

TABLE 3
Effect of antibiotics on prevention of liver necrosis in the rat (György et al., 17)

Supplement	Survival time	Gain 4 weeks
	days	*gms.*
Nor 2	34	4.4
Chlortetracycline 25 mg./day	110	24.0
Polymyxin	36	12.0
Streptomycin	50	25.0

TABLE 4
Effect of chlortetracycline on renal lesions (Baxter and Campbell, 2)

Supplement per kg. diet		Animals with normal kidneys
		%
None		18
Chloromycetin	6 gms.	0
Oxytetracycline	5 gms.	20
Chlortetracycline	5 gms.	80
Vitamin B_{12}	60 μg.	54
Vitamin E × 10		8
Choline	3 gms.	100

renal damage could also be prevented by choline feeding. Analysis of the liver and feces of the animals treated with chlortetracycline revealed only small increases in choline which were insufficient to account for the effect on the basis of an increased intestinal synthesis of choline. Since the diet was essentially choline-free, the response could not have been due to a reduction in choline destruction by the intestinal flora.

The vitamin sparing effect may account for the growth response produced by antibiotics on diets containing suboptimal amounts of vitamins. This explanation is inadequate to account for the growth increase obtained with antibiotics on adequate diets. The possibility exists that the antibiotics may stimulate the synthesis of unidentified growth factors. Although there is little evidence to support this view, one experiment has been reported in which either chlortetracycline or grass juice gave approximately equal growth responses in turkeys and a combination of the two was no better than either one alone *(30)*.

Many experiments have been made to determine whether antibiotics may modify the protein requirements. Burnside *et al. (7)* found that the response to chlortetracycline was much greater on a corn-peanut meal ration than on either corn-soybean meal or corn-fish meal diets. The growth on the unsupplemented peanut meal ration was approximately half that of the corn-fish meal diet, but on the addition of chlortetracycline the two rations gave essentially the same growth. The greater response to chlortetracycline on the peanut meal diet could have been due to an increased availability of peanut meal or to the suppression of a more unfavorable intestinal flora that may have developed on the peanut meal diet. Catron *et al. (9)* found that the protein requirements of swine for maximum growth were 2% less in the presence of an antibiotic. In studies with poultry, antibiotics have been reported to give slightly greater growth responses at lower protein levels but the protein requirement for optimum growth was not significantly changed *(31)*.

The most plausible explanation for the growth response given by antibiotics on adequate diets is the suppression of deleterious organisms within the intestinal tract. The observation that chicks reared in a germ-free environment grow faster than those under normal conditions *(27)* indicates that the intestinal flora are detrimental to the host. It has also been found that the antibiotic growth response may be greatly modified by the environment. Thus, Coates *et al. (13)* reported that chicks raised in the regular chick colony showed a marked response to penicillin while other chicks reared in new chick quarters several miles away where chicks had not previously been kept showed no response to the antibiotic. This same phenomenon was observed in other experiments, shown in Table 5, where the new and the old quarters were approximately 300 feet apart. The chicks in

TABLE 5
Effect of environment on growth response of chicks to penicillin (Coates et al., 13)

Supplement/kg. of diet	Av. wt. 21 days	
	Old quarters	New quarters
	gm.	*gm.*
None	168	188
40 mg. Proc. penicillin	192	188

the uninfected quarters grew at the same rate as those in the infected quarters which received penicillin. It thus appears that the penicillin overcame the deleterious effect of the microflora which existed in the infected quarters. This effect of "level of infection" in a particular environment on the antibiotic growth response has been observed in several laboratories *(6, 18)*. In some cases the growth in the new quarters without antibiotics was better than that in the old and infected environment with antibiotics. Thus the antibiotic is not always able to eliminate the harmful effect of the subclinical infection prevalent in regularly used animal quarters. In a more detailed study of the nature of the infection, Coates *(11)* employed a "semi" germ-free condition achieved by maintaining chicks in a transparent plastic box which contained sufficient feed for a 2-week period and which was supplied with a source of sterile air. Under these conditions no response was obtained to penicillin. The addition of whole gut contents of "infested" chicks to the feed produced a growth depression which could be prevented by penicillin. Gut contents from "non-infected" chicks or autoclaved gut contents from infected chicks produced no growth depression and the further addition of penicillin had no growth-promoting effect.

CLINICAL EFFECTS OF CONTINUOUS ADMINISTRATION OF ANTIBIOTICS

When it became apparent that antibiotics increased the growth rate of animals, questions were raised regarding the possibility of similar clinical effects. The marked effectiveness of antibiotics in restoring to normal the growth of "slow-gaining" or "runty" pigs stimulated interest in whether a similar result could be obtained in slow-growing children. In one series of experiments involving continuous feeding of chlortetracycline, Carter *(8)* administered 75 mg. of chlortetracycline twice a day to children from one to three years of age. Twenty children were used in the study; those receiving chlortetracycline gained an average of 6.5 lbs. per year as compared with 1.9 lbs. for the controls. The group receiving the antibiotic had less gastrointestinal upsets and diarrhea than the controls. There was no evidence of any significant development of chlortetracycline-resistant organisms during the course of the experiment. A large scale experiment on the continuous feeding of antibiotics to undernourished children has been reported by Schrimshaw *et al. (29)*. The children used in this study were undernourished Indian children, 7 to 12 years of age, subsisting on diets low in animal protein. Under these conditions the daily administration of 50 mg. of chlortetracycline produced small but statistically significant increases in height and weight. Similar, though more variable, responses were produced by 50 mg. of penicillin.

SUMMARY

Antibiotics are capable of producing growth responses in a number of species of animals and are used commercially in the feeding of poultry, swine and calves.

The feeding of antibiotics increases synthesis of water soluble vitamins by intestinal microflora and under certain conditions these may be utilized by the animal. On nutritionally complete diets the growth response is due to the suppression of deleterious microflora. The response on such diets is greatly modified by the "disease level" in which the animal is kept.

The continuous administration of antibiotics to children has resulted in increased growth and reduction in gastrointestinal upsets.

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Temperatures in Relation to Deciduous Fruit Production[a]

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The growth of deciduous fruits from bloom to harvest is strongly influenced by the prevailing temperatures. The relationships involved have been the subject of considerable research effort by the Department of Pomology of the University of California at Davis during the past 25 years. This paper, which reviews some of that research, should have interest not only for food technologists but also for all who are engaged in the chain of activities that bring fruit from orchard to market.

Apricots. Tufts *(9)* showed clearly the relation of temperature to the time of maturity of apricots. He compared three Royal apricot orchards, which were no more than 14 miles apart, but which differed as much as 2 or 3 weeks in time of harvest. The earliest maturity occurred in the orchard which was the warmest during the growing season, while the latest was in the orchard which was the coolest. With little or no difference in daily maximum temperatures between the orchards, the night temperatures, as expressed in the daily minimum, became critical. The higher the average minimum temperatures, the earlier the maturity of the apricots. Two of the orchards were only 4 miles apart, yet minimum temperatures were enough higher in the one instance that harvest was from 6 to 8 days earlier—a very significant difference for this district which ships the early apricots as fresh fruit to eastern markets.

The effects of higher temperatures as observed in the orchard were substantiated by Lilleland *(8)*. The apricot, like the peach (Figure 1), shows the 3 stages of development: first, a period of rapid growth; second, a period of slow enlargement; and third, another period of very rapid increase in size. By artificial heating Lilleland was able to shorten markedly the first growth period of the apricot. Tukey *(10)*, working with sour cherries in the East, has interestingly enough given additional support to the observations of Tufts and Lilleland, even though working with another species and in another climatic area.

With such marked effects of temperature on apricot development, predictions of the time of harvest based on early season temperatures have been highly successful. Baker and Brooks *(1)* showed a high correlation between temperatures during the first 6 weeks after full bloom and the time of harvest of Royal apricots. Brown *(3)* found that just as satisfactory predictions could be made by considering the average of the daily mean temperatures for 42 days after full bloom as by using the more cumbersome heat unit notation of Baker and Brooks. He found a correlation of —0.9515 between the mean temperature for 42 days after full bloom and the time of harvest of Royal (Blenheim) apricots in the Brentwood district and —0.8147 in the Winters district. Regression equations derived from the data for these districts permit estimates of harvest which fall within ± 3 days of the observed dates about 70% of the time. Similar prediction equations have been derived for French prunes *(1)*, Bartlett pears *(2)* and Gravenstein apples *(5)*. Accuracy in prediction depends on the length and accuracy of the records available for the derivation of the formulas.

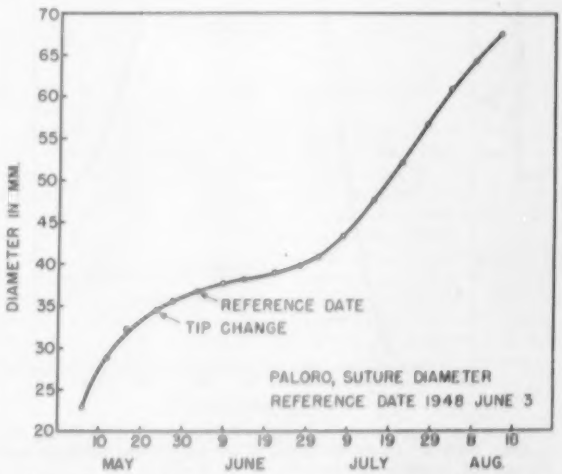

Figure 1. Typical peach growth curve, showing the point at which the pit begins to harden (tip change) and reference date (7).

Such predictions are of value to the grower, packer, shipper, processor, and supplier. Growers are able to arrange their operations in advance of harvest. For example, if a pre-harvest irrigation is needed, the water can be applied far enough in advance to allow the surface soil to dry out in time to be made ready for the harvest traffic. Arrangements for harvest labor and equipment are facilitated. Likewise, packers and shippers can be better prepared to meet the harvest time demands and adjust their operations with respect to the various commodities which they handle. For canners and can suppliers, reliable forecasts of harvest permit better scheduling of operations and more efficient use of facilities and equipment.

The work with harvest predictions has led to the derivation of the apparent efficiencies of temperature in fruit development and to a better understanding of the relative effectiveness of different temperatures *(4)*. The apparent efficiencies of temperatures in promoting apricot fruit development increase from a minimum of zero at 40° F. to a maximum or optimum at about 72°, decreasing at higher temperatures such that at 105° F. the efficiency is about 33% of optimum (Figure 2).

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The temperature effects noted by Tufts *(9)*, Lilleland *(8)*, and Tukey *(10)* are more understandable in the light of these differences in the effectiveness of different temperatures. Furthermore, the fruit breakdowns, such as pit-burn of apricots, that have long been associated with high temperatures near harvest, are more readily

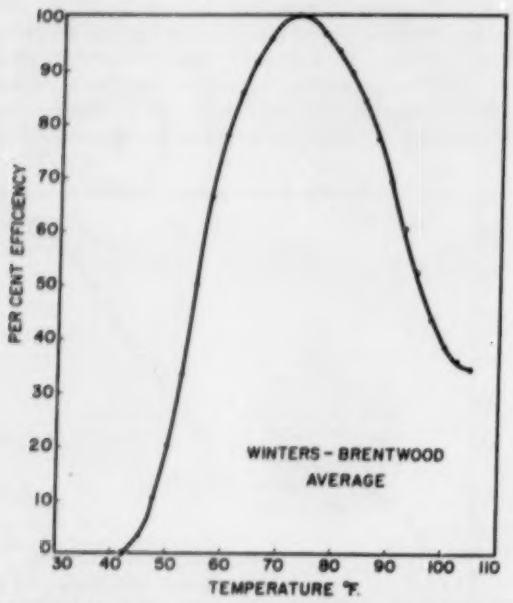

Figure 2. Apparent efficiencies of different temperatures for apricot fruit development, average of data from Winters and Brentwood, California (4).

understood when the low apparent efficiency of temperatures above 100° F. is recognized. Practical uses of the temperature efficiency information in relation to various temperature problems are being explored in work now in progress.

Cling peaches. The use of temperature data in the prediction of earlier stages of fruit development is illustrated in the prediction of reference date for cling peaches. Reference date is arbitrarily defined as a date 10 days after the time that the tips of the pits of peaches begin to harden *(7)* (Figure 1). Physiologically, the tip change, the beginning of pit hardening, is the important point. However, the extra 10 days is added so that critical fruit measurements made at this stage of fruit development will fall just into the second growth period, a time when the day to day increase in fruit size is very small and uniform.

Reference date is of significance to the grower and the canning peach industry because of the high correlation between fruit size at reference date and size at harvest. If estimates made at reference date indicate unfavorably small harvest sizes because of overloaded trees, fruit thinning to promote larger harvest size can be employed. Also, crop yield and production estimates made in relation to reference date are becoming increasingly valuable. These are of consequence to grower and canner alike in establishing the marketing program for the crop.

A forecast of the time of occurrence of reference date is helpful in organizing the program of collecting data from orchards in the various peach districts for making fruit size and tonnage estimates. Davis *(6)* in unpublished work has found that a very satisfactory prediction of the occurrence of reference date is possible, based on the number of hours of temperature above 60° F. for 60 days after February 25. The 60° base appears to be the most satisfactory because it includes the most efficient temperatures for peach development, optimum being about 78° F. With temperatures during the interval involved seldom over 90°, the hours over 60° F. reflect the high degree of growth favorability of temperatures near optimum and are highly correlated with the rate of fruit development. In this formula the time of full bloom is disregarded since it was found by trial and error that the best correlations and predictions resulted if February 25, an arbitrary date prior to bloom, is used as a starting date for counting the hours above 60° F. Fair predictions are possible after 45, 50 or 55 days after February 25, but the most reliable ones are based on the 60-day interval.

The actual reference date is predictable with an accuracy of ± 4 days in 95% or ± 3 days in about 80% of the time. Prediction of reference date also serves as a satisfactory estimate of harvest date since under California conditions the time from reference date (or pit hardening) to maturity is remarkably uniform in length year in and year out. The greatest variations in the length of the peach growing season occur as variations in the length of the first growth period which concludes with the start of pit hardening. The reason for this lies in the fact that in California peach districts the greatest year to year fluctuations between favorable and unfavorable temperatures occur in the spring from full bloom to about the middle of May. From then until September the favorability of growing temperatures is high and remarkably uniform year in and year out—partly because periods of abnormally low or high temperatures are of short duration and usually balanced out with opposite conditions during other periods of the summer. Therefore, temperatures during the first growth period or nearly up to pit hardening, by accounting for the greatest variable in determining the seasonal rate of fruit development, serve satisfactorily as the basis of estimating harvest time.

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Inhibition of Mold and Yeast Development in Fish Products

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Growth of molds and yeasts in smoked fish was strongly delayed when about 0.05 to 0.1% sorbic acid was incorporated in the flesh during the brining process. Development of "dun" in salted fish, which is caused by the mold Sporendonema epizoum, was likewise markedly inhibited by sorbic acid. Sorbic acid appears to be quite stable in fish muscle. Neither chlorotetracycline nor tetracycline was of any value in retarding mold or yeast development in such fish products.

Loss of quality of fish and fish products due to development of mold and yeasts is of far less frequent occurrence than that resulting from bacterial action. However, with some products such as smoked, salted, or dehydrated fish, storage conditions are frequently such that the moisture content may be quite adequate for mold development and yet tend to hinder bacterial growth. Since sorbic acid (SA) has proven a valuable fungistat for use with cheese *(8)* and is not injurious to health *(2)*, the possibility that it could be employed alone, or in conjunction with chlorotetracycline (CTC), to retard development of molds and yeasts in fish was investigated. A brief report concerning this investigation has already been published *(1)*.

EXPERIMENTS WITH SMOKED FISH

In the first experiment 20% (W/V) sodium chloride solutions, with and without the following additives, were prepared, the pH benig adjusted to approximately 7.0 to effect solution of the SA where necessary: SA 0.1 and 0.2%; CTC, 0.0005 and 0.001%, and SA 0.1% + CTC 0.0005%. Pieces of fresh halibut *(Hippoglossus stenolepis)* approximately 3 x 3 x 1 in. in size were immersed for 15 minutes in the above solutions, drained and left exposed to air at room temperature for 2 hours. They were then smoked with oak smoke in a controlled tunnel for 6 hours at 20° C. and 70% relative humidity and stored at 4° C. in polyethylene bags. At regular intervals they were inspected visually for signs of mold development.

In a second similar experiment pieces of halibut, red spring salmon *(Oncorhynchus tschawytscha)* and sable-fish *(Anoplopoma fimbria)* were treated as in the first experiment, except that the SA concentrations used were higher (1.0 and 0.5%) and the immersion period in the brines was extended to one hour. In a third experiment pieces of sable-fish and halibut were treated by "dusting" their surfaces with powdered SA (1 g. per 800 g. fish) or by wrapping them in polyethylene sheets the surface of which had been sprinkled with SA (0.5 g./100 in.^{2}).

In addition to visual examination certain of the stored samples were subjected to direct bacterial counts *(9)* and to viable yeast and mold plate counts using "Difco" wort agar to which 5 p.p.m. of CTC had been added to inhibit growth of bacteria. Plates were incubated 5 days at 25° C.

Results obtained in the first experiment showed that the rather low concentrations of SA used and the rather short immersion time only retarded mold development on treated samples about 2 weeks in comparison with untreated samples. Pronounced mold growth had occurred on all samples in one month and the CTC treatment was without noticeable effect.

Much more promising results were obtained in the second experiment in which the samples were given a more prolonged immersion in stronger SA solutions. With these samples SA not only delayed or entirely prevented development of visible mold after 40 days at 4° C., but also effected a marked decrease in the population of viable molds and yeasts (Tables 1 and 2). Growth of neither molds nor yeasts was inhibited by CTC alone, and when it was used in conjunction with SA it usually reduced the effectiveness of the latter slightly. With sable-fish SA did not delay development of visible mold as markedly as with the other fish, and this may have been because the high fat content of the fish reduced the amount of SA absorbed.

No mold growth occurred in 50 days in samples which were either treated with SA by the dusting procedure or which were stored in wrappers which were treated with the fungistat.

TABLE 1

Inhibition of visible mold development in smoked fish by sorbic acid and chlorotetracycline

Concentration of preservative in brine (%)	Visible mold after 40 days' storage at 4° C.		
	Salmon	Halibut	Sable-fish
None	++++	+++	+++
SA, 1.0	−	−	+
SA, 0.5	−	−	+
CTC, 0.001	++++	+++	+++
SA, 0.5 + CTC, 0.0005	++	++	++

[1] Legend: − = None, + slight, ++ moderate, +++ marked, ++++ intense.

TABLE 2

Effect of sorbic acid and chlorotetracycline on growth of yeasts and molds in smoked fish

Concentration of preservative in brine (%)	Viable yeasts (Y) and molds (M): colonies x 10^6 per g.					
	Salmon[1]		Halibut[1]		Sable-fish[2]	
	Y	M	Y	M	Y	M
None	>200	>200	147	14	6.5	1.7
SA, 1.0	....	2.0	....	0.5	1.0	<0.01
SA, 0.5	0.5	1.0	0.06	<0.5	2.0	0.09
SA, 0.5 + CTC, 0.0005			36	0.7	3.5	0.03

[1] Stored 47 days.
[2] Stored 42 days.

EXPERIMENTS WITH SALTED FISH

One of the common causes of spoilage in salted fish such as cod is the so-called "dun" which is caused by a halophilic brown mold *Sporendonema epizoum (4)*. This condition is difficult to control, and the measures which have been suggested *(3)* have not been particularly successful.

In the present investigation cultures of *S. epizoum* were isolated from a typical sample of "dun" salt cod by shaking a portion of the fish with 13% sodium chloride solution and streaking a loopful of the suspension over the surface of solidified Shoop's medium *(7)* in petri plates. Isolated colonies developed within 7 days and were transferred to agar slopes of the same medium and the spores which developed used in the following experiments.

Portions of lingcod approximately 2 x 2 x 0.5 in. in size were cut so that the skin was retained intact, and were dry salted by the "Kench" cure method *(5)*. The preservatives employed were incorporated into standard dairy salt by grinding in a mortar and finally blending thoroughly with a food mixer. Fish samples treated with salt alone or with salt containing incorporated SA, CTC or both (Table 3) were stored 5 days at 4° C. to ensure adequate salt penetration. The excess of salt was then scraped from the surfaces of the samples which were then sprayed with a light suspension of spores of *S. epizoum* in 13% sodium chloride solution. They were then stored in a cabinet at 25° C. and 75% relative humidity.

TABLE 3

Effect of various preservatives in inhibiting development of "dun" in salted fish

Substance incorporated in dry salt (%)	Expt. 1 (fish stored 24 days)	Expt. 2 (fish stored 35 days)	Expt. 3 (fish stored 60 days)	Expt. 4 (fish stored 60 days)
None	++++	+++	+++	+++
SA, 0.05	+			+
SA, 0.10	−			−
SA, 0.20	−	−	−	
SA, 0.10 + CTC, 0.005			−	
SA, 0.10 + CTC, 0.010		+		
SA, 0.05 + TC, 0.01				+
SA, 0.2 + TC, 0.02	−			
Sodium benzoate, 0.05	+++			+++
+ NaH_2PO_4, 1.0	++			++
Sodium propionate, 0.1				+++
CTC, 0.01			++++	
CTC, 0.02		+++		
TC, 0.01				+++
TC, 0.02	+++			

Legend: − to ++++ as in Table 1.

Four separate experiments were carried out, the samples being subjected to an almost daily visual inspection to ascertain whether "dun" discoloration had developed. The results (Table 3) show that 0.1 or 0.2% SA incorporated in the dry salt inhibited development of "dun" discoloration up to 60 days. The antibiotics CTC and tetracycline (TC) were ineffective when applied alone, and in most instances when used together with SA somewhat neutralized its beneficial effect. Sodium propionate and sodium benzoate plus NaH_2PO_4 *(3)* were almost or entirely ineffective in inhibiting "dun" development.

Sorbic Acid Content of Treated Samples

The amount of SA present in certain samples from the above experiments was determined as follows. Finely divided portions, 3 to 11 g. in weight depending on the SA content, were steam distilled in the presence of 50 g. of magnesium sulphate and 50 ml. of water and the SA determined spectroscopically in the distillate according to the procedure of Melnick and Luckmann *(6)*. Excellent recoveries were obtained in experiments in which known amounts of SA were added to fish samples.

The results obtained on analyses of certain samples of smoked and salted fish are recorded in Tables 4 and 5.

TABLE 4

Recovery of sorbic acid from smoked halibut and sable-fish

SA concentration in brine (%)	Sample	Storage time in days at 4° C.	SA content in flesh (%)
None	Sable-fish	10	0.002
None	Sable-fish	40	0.001
1.0	Sable-fish	9	0.100
1.0	Sable-fish	9	0.105
0.5	Sable-fish	10	0.056
0.5	Sable-fish	10	0.048
None	Halibut	13	0.002
None	Halibut	13	0.003
1.0	Halibut	1	0.160
1.0	Halibut	5	0.140
0.5	Halibut	5	0.086
0.5	Halibut	6	0.088
0.5	Halibut	42	0.085
0.5	Halibut	42	0.091

TABLE 5

Recovery of sorbic acid from salted lingcod

SA added to dry salt (%)	Storage time in days at 0° C.	Storage time in days at 25° C.	SA content in flesh (%)
None	5		0.001
None	5		0.002
None		60	0.002
0.2	5		0.037
0.2		41	0.032
0.2		68	0.030
0.4	3		0.036
0.4	6		0.034
0.4	11		0.033

They indicate that with the different procedures employed the fish contained only about 10 to 15% as much SA as was present in the brines used. In general the SA content of treated fish did not appear to decrease appreciably during the storage periods studied.

Acknowledgments

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The Value of Dehydrated Vegetables as a Supplement to the Proteins in Milled Wheat Flour and Corn Meal*

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The supplementary value of several dehydrated vegetables to enriched milled wheat flour and non-enriched corn meal is reported. Marked increases in rat growth and pronounced improvement of protein efficiency are demonstrated.

Although dried foods have been used for many centuries, dehydration of foods received their greatest interest during recent world wars. Not only was it necessary to conserve shipping space in transporting millions of tons of food to our Armed Forces and our allies but it was also necessary to conserve stategic metals used for containers. Recent wars have also focussed attention on the need to conserve all food produced for home consumption. Dehydration makes it possible to save much food which otherwise goes to waste for lack of suitable equipment and containers needed for canning it.

Under the stimulus resulting from increased demands by the Army and Navy for dehydrated foods, rather revolutionary advances along technical lines took place in the dehydration industry. Much of the superiority of the new dehydrated foods is due to recognition and application of basic principles related to varietal differences and degree of maturity in the raw product, as well as pioneering developments in washing, bleaching, and drying. Emphasis placed by the industry on fundamentals—such as inactivation of enzymes, prevention of rancidity, maximum vitamin content, and formation of dark pigments—has resulted in superior products *(4, 5, 6, 7)*.

In the evaluation of dehydrated foods, the retention of nutritive value is an obvious criterion. The literature thereon is meager and confined only to influence of storage on vitamin content, rancidity, and taste. Since there is no information available on the nutritive value of nitrogenous ingredients in dehydrated foods, and since it is impossible to study such foods as the only source of proteins in rations because of the high proportion of mineral ingredients in them, it was thought of interest to investigate the supplementary value of several dehydrated vegetables to the proteins in enriched milled wheat flour and in non-enriched milled white corn meal. Table 1 gives the total protein contents of the dried vegetables used which vary from 18.4 to 29.0%. The dehydrated vegetables constituted 12.9 to 23.3% of the total proteins in the rations.

TABLE 1

Total protein content of various dehydrated vegetables

Dehydrated vegetables	Total protein
	%
Lettuce	20.7
Spinach	24.1
Mustard greens	27.8
Cauliflower	23.2
Green beans	18.4
Watercress	29.0

EXPERIMENTAL PROCEDURE

This study was carried out on the Wistar strain of albino rats. The animals were about 27 days old when started on experiments and weighed 52 to 55 g. each. They were weighed weekly and accurate records were kept of food consumption. There were 12 animals in each group, the sexes being equally divided. The experimental period was 10 weeks. The rations containing enriched milled wheat flour had a protein content of 8%. When they were supplemented with 5% of dehydrated lettuce, spinach, mustard greens, watercress, cauliflower or green beans, such amounts of wheat flour were used so as to keep the total protein content at 8%. The corn meal rations contained a maximum of 6.23% protein, and when such rations were supplemented with dehydrated lettuce, mustard greens, green beans, and watercress, the amounts of corn meal were calculated so that, in combination with the dehydrated vegetables, the total protein content of the rations was kept the same, i.e., 6.23%. Therefore, any additional growth obtained by virtue of the added dehydrated vegetables should be considered as supplementary values from the amino acids supplied by them. The rations also contained 2% Cellu-flour for roughage; 4% of Sure's salt mixture No. 1 *(8)*; 7% vegetable shortening; 2% cod liver oil; 1% wheat germ oil; and the rest Cerelose (glucose). The following crystalline components of the vitamin B complex were administered daily to each animal separately from the ration: 25 γ each of thiamine, riboflavin, pyridoxine, and niacin; 150 γ calcium pantothenate, 3 mg. p-aminobenzoic acid, 6 mg. choline chloride, and 1 mg. inositol. Vitamins A, D, and E were furnished by cod liver oil and wheat germ oil in the rations. The yardstick for evaluation was protein efficiency ratio, expressed as gains in body weight per g. of protein intake. The results of this study are summarized in Table 2.

RESULTS AND DISCUSSION

It will be noted from Table 2 that with the exception of dried green beans all the dehydrated vegetables used produced marked supplementary values to the proteins of enriched milled wheat flour, the greatest response having been secured with dehydrated mustard greens, as evidenced by 186.8% increased growth and 104.9% increase in protein efficiency ratio. The greatest growth followed the use of dried watercress, i.e., 203.1% increased gains in body weight, but because in this group there was increased food consumption, the increase in protein efficiency was less, i.e., 73.8%. In the case of the group receiving dried lettuce the increase in growth, 41.6% and increase in protein efficiency of 36.1% were not due to increase in food intake but specifically due to

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TABLE 2

The supplementary value of dehydrated vegetables to the proteins in milled wheat flour (MWF) and milled white corn meal (MWCM) (Average results per animal)

Dried vegetables	% in rations	Protein in rations	% of total protein	Gains in body weight		Total food intake	Protein intake	Protein efficiency	Ratio[1] increase
					increase				
		%		g.	%	g.	g.		%
MWF	81.6	8.0		12.8		259	20.3	0.61 ± .04[2]	
MWF	71.1	6.97							
Dried lettuce	5.0	1.03	12.9	17.8	41.6	269	21.5	0.83 ± .05	36.1
MWF	69.4	6.80							
Dried spinach	5.0	1.20	15.0	22.2	73.5	296	23.7	0.94 ± .06	54.1
MWF	67.5	6.61							
Dried mustard greens	5.0	1.39	17.4	36.7	186.8	367	29.4	1.25 ± .07	104.9
MWF	66.8	6.54							
Dried watercress	5.0	1.46	18.3	38.8	203.1	459	36.7	1.06 ± .03	73.8
MWF	67.8	6.64							
Dried cauliflower	5.0	1.36	17.0	17.8	41.6	277	22.2	0.80 ± .06	31.1
MWF	72.3	7.08							
Dried green beans	5.0	0.92		17.9	40.0	322	25.8	0.70 ± .04	14.7
MWCM	83.0	6.23		1.7		176	11.0	0.16 ± .02	
MWCM	69.3	5.20							
Dried lettuce	5.0	1.03	16.5	10.6	523.5	305	19.0	0.56 ± .04	250.0
MWCM	64.5	4.84							
Dried mustard greens	5.0	1.39	22.3	17.6	935.3	340	21.2	0.83 ± .07	418.7
MWCM	70.8	5.31							
Dried green beans	5.0	0.92	14.8	5.2	205.3	251	15.6	0.33 ± .05	106.2
MWCM	63.7	4.78							
Dried watercress	5.0	1.45	23.3	17.3	917.7	333	20.7	0.83 ± .07	418.7

[1] Expressed as gains in body weight per gram of protein intake.
[2] Standard deviation of the means.

the supplementary amino acids furnished by the lettuce.

The supplementary values of dehydrated lettuce, mustard greens, green beans, and watercress to the proteins in corn meal were phenomenal, i.e., increases of 523.5, 935.3, 205.3, and 917.7% increased growth, respectively; and increase of 250.0, 418.7, 106.2, and 418.7% increase in protein efficiency, respectively.

Results of this study may have applications in feeding overpopulated and undernourished nations during periods of food shortage, during famines, and during wars; in the Orient where over 80% of the proteins are derived from plant foods consisting chiefly of cereal grains *(3)*; and also in Latin American countries and in Africa where there exists an inadequate supply of high quality proteins *(2)*.

Of all the proteins used for human consumption only those of animal origin are considered to be of superior biological value, but it takes approximately 2 acres of land to graze a cow, if soil and moisture conditions are favorable. The conversion of vegetable calories into animal calories has long been known to be inefficient, only 15% of vegetable calories is recovered in producing milk, 7% in eggs, and only 4% in beef *(1)*. It is consequently impossible to raise sufficient cattle for human consumption in overpopulated and underprivileged countries. Plant proteins of inferior biological value must necessarily provide sustenance for the greater portion of the world, and these are supplied chiefly by the cereal grains *(9)*. Although the protein efficiencies obtained in this study were not in the order of magnitude of that secured with animal protein, the improvements were so marked that this type of fortification in overpopulated countries would be desirable.

SUMMARY

Several dehydrated vegetables when used at 5% of rations have been found to be excellent sources of amino acid supplements to the proteins in enriched milled wheat flour and non-enriched milled white corn meal, as evidenced by marked increases in growth and pronounced increases in protein efficiency.

Acknowledgment

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The Food Engineer and Food Industry Profits[a]

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The United States presents to history the first example of a great population suffering seriously from an excess of food. Food surpluses threaten physical, economic, and political health. Fortunately, on balance, the current American triumph over the starvation threat is not regrettable. It offers opportunities as well as problems to medical men, to political leaders, and to the country's greatest industry—the food industry.

Credit for the tremendous accomplishments in quantity, quality, and convenience in food production, preparation and distribution in such a brief period depends upon who is speaking—and in the complicated interdependent system that is the United States, it is absurd for any one class to claim credit. Mechanical engineers admire the Rolls-Royce engine, and think of the great mechanical engineer who made it possible. But the full dramatic history of Rolls-Royce makes it crystal clear that Rolls without Royce, or Royce without Rolls, would have remained good English names unknown outside their home towns. Royce was an engineer; Rolls, a business man.

If we take the fertile ground of the American business atmosphere as given and then seek credit for the epoch-making advances in human food supply, we find a similar partnership high on the list. That partnership is the combination of management and engineering—symbiotic, synergistic, creative, constructive, and profitable.

In accepting the Oscar for their performance, this winning team will acknowledge the contribution of the fundamental scientists—the bacteriologists, the biologists, the chemists, the physicists, and the mathematicians. There is a special bow to the non-engineer food technologists. They will bow to the banker who has confidence and courage, to the employees that cooperate in advanced practices, to the advertisers and the salesmen who create markets, and above all to the director of their production—the great American consumer. But here near Hollywood the Oscar goes today to the food engineer-management partnership.

"EFFECTING LIAISON WITH MANY SOURCES OF TECHNICAL AID"

It is only a few years ago that Food Technologists began to be recognized; it was in the 1930's, for example, that the Institute of Food Technologists was formed. There is now a growing tendency to recognize the special combination of qualifications that make up a Food Engineer. At least one school offers a combined curriculum giving both engineering and the elements of the life sciences. Other schools emphasize engineering in their food technology curriculum. Several of the larger food companies hire principally straight mechanical, chemical, or electrical engineers in their recruiting programs, in their annual college ivory hunts. In their apprenticeships most of these men acquire at least an elementary knowledge of the life sciences, an appreciation of sanitation, and an awareness of the fugitive nature of food flavor and quality—in a word they become aware of management and learn how to work with it.

There is little relation between the milling of flour and the preparation of canned luncheon meat. We might also cite maraschino cherries, if maraschino cherries can be called food. But varied as is the industry and its products, it has one common denominator. As was once said of a great mongrel dog, size is the biggest part of it. Large volume and low profit margins are characteristic. An engineer's heaven. The packing houses of Cairo in Egypt seem as archaic to the food engineer as the nearby pyramids. Were such practice still in vogue here, the cost would force meat off the laboring man's table. Engineering induced and supported by large volume—mechanical handling, production lines, refrigeration—has kept our cost margin down.

Many specialized segments of the food industry, with their different profit margins, different markets, and different manufacturing practices, require different approaches to the application of engineering. The high-margin specialty products stress novelty, premium quality, product development, and research. At the other extreme are long-standardized volume products stressing cost margins almost exclusively. It is a matter of emphasis. Research has its hardest time entering the old-time high-volume, cost-conscious volume field, and engineering cost refinements come last in the novelty, specialty, low-volume field.

The total national investment in research in 1952 was $3½ billion, of which the food industry contributed $23 million. According to the 1953 Report of the Bureau of Labor Statistics and the Research and Development Board, in 1951 the food manufacturing industry spent 0.3% of its gross sales dollar on research. This compares with 0.6% for petroleum products research and 2.5% for research by the chemical industry.

In 1951 the food industry employed some 1500 research engineers and scientists in addition to another 3000 research technologists. The number of engineers in the food industry has increased 430% since 1930 and is continuing to increase. But in relation to the size of the industry, the number is still small, indeed. The industry may well be on the verge of a great expansion in the use of food engineers such as the petroleum industry experienced when it discovered chemical engineering. Few, if any, industries offer so obvious an opportunity now.

Engineering plays a dual role in the industry—it shares with research scientists their responsibility for

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creative work, for improvement of quality, and for the maintenance of quality. At the same time, engineering shares with financial and accounting personnel the quantitative aspects of management. Engineering contributes constructively to both research and improved managerial practice.

Convenience has been the great catchword, but the industry is finding that it cannot stop with convenience. Only an English tea drinker would call the first soluble "coffee" coffee. It sold because convenience was King, but by stages soluble coffee became a beverage, until now it approximates good coffee and at its best is better than most housewives brew from the bean. Once quantity was assured, and convenience achieved, the consumer began to look for quality and flavor values. We are breeding a nation of gourmets.

Now a critical consumer means opportunity. Demand for quality by millions of gourmets can be met only by well-engineered, well-managed production and distribution. Well-managed, alert companies have an opportunity to establish and maintain their position, against irresponsible, unstable, cost-cutting competition. With volumes large and unit prices high, even minor improvements and precision in quality standards and uniformity pay dividends.

With quantity, convenience, and high quality available, price becomes important. And low cost, high volume is a matter of engineering. An engineer has been defined as a man who can do for one dollar what anyone can do for ten. Profit margins will continue to narrow with competition, and good food engineering will increase in significance. With an intelligent combined team attack on improving quality and reducing cost, great markets and great profits are possible.

Food Engineering in its 25th Anniversary issue listed a wide range of engineering advances in the food industry during the quarter century period. They all point to a much more sophisticated engineering practice in meeting competition, and increased demand for food engineers. They make clear the difficulty that will be experienced increasingly by members of the food industry that attempt to continue without adequate food engineering aid.

Some years ago the New England Council studied the problem of research for the small company. How can a small company utilize and profit by research? Its budgets are too small for the maintenance of an adequate research staff, or for sponsorship of worthwhile applied research at institutions. Careful study by a team of research men and industrialists came up with an answer that still holds good. They should hire one or more science or engineering graduates, even, if necessary, for production or sales positions, and then look to them for liaison with the world of science, research, and technology. They will help use effectively the enormous aid available from the supply companies—the manufacturer of equipment, of raw materials, and even of containers. Through such men the whole domain of current research can be tapped by even the smallest company.

In this way, modern managements of companies of all sizes look to their engineers to establish effective liaison with the many sources of aid, including the universities, the machinery builder, the supplier of materials and containers, and outside institutions generally. Great advancements come from the outside. Certainly no one company can now do all its new development, and it may well ask of its technical staff that it place special emphasis on establishing effective "international" relationships in the world of technology.

It is the engineer's business to know good design and best practice. It has been said that a canner can be excused for not scrapping an old blancher—but not for failure to give that blancher the benefit of best modern practice. Similarly, there is no excuse for purchasing food processing equipment that is obsolete. It is a small food plant, indeed, that cannot employ engineering aid for protection against such drains on profits. Around and through the industry, not too carefully hidden and readily available to a trained food engineer, is an enormous amount of unutilized know-how. It is a gold mine that can be tapped by the proper combination of entrepreneurial sense and competent food engineering. Fortunately much of it can be used without elaborate expensive programs or heavy investments, but the training, experience, and awareness of the special characteristics of the industry possessed by the food engineer are requisite.

To aid further in early and profitable use of technology, many companies are advancing technical men to the inner circles of company policy and administration. This step has paid great dividends in the chemical industry, where it was perhaps most obvious. The practice seems bound to spread as advanced technology becomes increasingly important competitively.

IN TECHNICAL AND MANAGERIAL UNITY THERE IS STRENGTH

The technical man often sees interesting technical objectives that have no great commercial or profit significance, or which are impractical investment-wise. The lay business man often sees opportunities that are technically difficult or impractical. Both may miss great opportunities that are both practical of attainment and worthy as profit objectives merely by unawareness of each other's area. In combination, by evaluating opportunities, defining objectives, and planning and maintaining a proper program, they can make profit.

Much of the problem of defining objectives can be made an engineering matter. Even product choice and diversification is becoming an engineering specialty. The analysis of research objectives—the research and technical audit—involves both technical and commercial sense and sensitivity.

Plant location, plant layout, plant operation require close cooperation between management and engineering. Increasingly the engineer participates in the policy on which they are based. Inventory policy, for example, is no longer left to the sales manager, or the treasurer, or the production manager, for sole or even principal determination. Inventory is studied as an engineering problem with management's key objectives as the measuring stick. Over-all return on investment may, for example, be the principal determining factor.

These currently are fringe developments. Machine design, construction, and selection and plant layout and

operation are obviously the basic engineering activities that permit the industry to serve the public so well. Their intelligent support by management has made profits. Fortunately there are still greater opportunities open to those who see and act on them. The most profitable opportunities seem offered to those managements that establish the most effective working relationship with good engineering.

IN SUMMARY

Summarizing, applied technology has put the United States in the new and historically unique position of having an abundance of food for a great population. Simultaneously, advances in science and engineering have made available a multitude of potential improvements in the collection, processing and distribution of this abundance of food stuffs.

Few, if any, of these improvements have been exploited fully by the food industry. Here remains an enormous reservoir of opportunity in the country's greatest industry, a reservoir of opportunity for service by the engineers and for profit by the entrepreneurs that back them. We need more food engineers and more food industry companies employing more food engineering profitably. The food industry should then show a higher margin of profit, and the public get yet greater convenience, lower cost, and better food.

Pediatric Food Problems[a]

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It is not unusual for the physician counseling the mother on well baby problems to say simply, "Start the baby on vegetables, now"—and a new food is introduced into the baby's diet. We seldom stop to think of the technical progress behind such a statement. This group well knows the time, energy, and money expenditures which have finally delivered the present high standard of prepared infant foods. You undoubtedly realize that a part of the reward for this effort is a revision of the infant morbidity and mortality tables so that not only are the total rates lower, but new diseases have risen to the top of the lists to replace the dreaded diarrheal diseases of 40 years ago. The contributions of medicine and sanitary engineering are shared with the food technologists in this achievement.

A burden lifted. In addition to this direct contribution, other equally important aspects of this progress can be cited. When the physician spends only one minute adjusting the diet, he then has time for discussion of some aspects of preventive pediatrics which have recently become increasingly important.

The physician is now freer to discuss the infant's physical and mental growth characteristics in more detail with the mother. Many of her anxieties concerning the behavior of her baby can be calmed, and many prevented if she has an authoritative idea of what to expect in these areas. We have seen fit to revise the pediatric curriculum in medical schools, so that the young physician in training spends more time learning to counsel parents on the "human side of the baby" rather than on the techniques of food preparation. The psychiatrists assure us that this approach is of inestimable value in the prevention of neurotic children.

Since accidents have now become the major threat to the child past one year, our attention as physicians must turn more toward accident prevention. The practice of educating the mother in how great this hazard is to her child, and what she can do to protect him from it is becoming widespread among physicians caring for children. This comes at a time in the child's life where he was formerly endangered by his "second summer," a term which used to imply a high incidence of diarrheal disease. Since it is common that the infant is eating mainly table foods at this time and even so is little threatened by diarrhea from contaminated food, it seems appropriate to point out that it is not only the safety of the infant foods, but also of all prepared foods which we rely on for this freedom of time.

The most important aspect of this situation, however, has yet to be mentioned. That is the burden that has been lifted from the mother in food preparation and the resultant time she gains to apply the physician's advice. She now has time to spend with the baby as a new person in the family instead of in preparation of suitable food for this new mouth to feed. She has time to get acquainted with her baby, so to speak, thus increasing the chances for good psychological adjustment of the entire family.

Nutritional considerations. Along with the niceties and advantages of prepared foods, we must concern ourselves with their limitations. It needs only passing mention here as to how quickly the returns begin to diminish when food is processed more than a minimal amount. I refer not only to the cost aspects, but also the nutritional contents. Except for extremely unusual circumstances, such as survival rations, there is no demand for a single food which supplies all known essentials. The indiscriminate "improvement" of basic foods by the addition of vitamins, mineral mixtures, and chemicals of vague origin will find little support from physicians. This is not to imply that nature cannot be improved upon. The enrichment of flour, the addition of vitamin D to milk, and the reconstitution of vitamin C

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, June 28, 1954.
[b] Markle Scholar in the Medical Sciences.

in processed citrus juices are well established and accepted procedures. The addition to milk, however, of more protein, vitamins A, B complex, C and E, as well as minerals, and the marketing of this milk as a product for routine consumption is not only uneconomical, but is misleading to the public. The impression is easily conveyed through advertising and without violating any legal limits that this type of food can, or even should, replace more potent sources of these constituents in the dietary. We are far advanced in our knowledge of nutritional requirements when we look back at where we were even 20 years ago. We are not far enough advanced in knowledge of human nutrition to be able to assemble a single product which we can guarantee is complete.

Recent experience in infant feeding has pointed out two obvious errors of omission in a dramatic way. Ten years ago, more or less, we first became conscious of an increasing incidence of a peculiar type of anemia occurring in young infants. There was no question of iron deficiency in these babies, and the anemia was termed "megaloblastic anemia of infancy." We have subsequently learned that this results from a lack of, or a derangement in the needs for vitamins C, B-12, and folic acid. The infants who developed the anemia were nearly all fed on commercially prepared infant formulae and on this alone. The formulae were labelled as "complete infant foods" and in good faith. The discovery that these preparations were to blame led to a modification of their contents with the result that we no longer see this disease resulting from dietary deficiency. However, within the past 2 years one of these same products in its modified form was again dramatically singled out. Some infants fed this preparation alone began to have convulsive seizures. In a remarkably short time it was discovered that these babies suffered from pyridoxine deficiency, and that in spite of the good faith of the reputable manufacturer, the product failed to supply the infants' needs for pyridoxine. Up to that time little was known of the need for pyridoxine in human nutrition, and we still do not know exactly how much is needed. The point is that through the processing of milk to modify and supplement its digestibility, two serious mistakes have been made. Two previously unrecognized nutritional deficiency states have come to light, and we are now conscious of several new nutritional requirements. How many more of these vaguely defined or as yet undiscovered requirements will be discovered in the near future is impossible to predict, but it should be emphasized again that no one food can be considered complete at this time. The early introduction of solid foods into the infant's diet has, among other advantages, protected the infant against the unknown deficiencies of a single processed food. A variety of foods from a variety of sources seems to be our best method of offering complete nutritional requirements.

Special dietetics. There are a few outstanding problems of special dietetics for sick children that merit mention. It is a well established observation that the child's appetite, when unhampered by illness or mental conflicts, will usually be governed by need. We seldom see a young baby who is physically well that does not eat well. Because the normal growth rate slows markedly about age 2 years, the child fails to increase his food intake as he consistently did during the first 2 years. Day by day the eating habits of a 2- or 3-year old child are erratic. At one meal he may eat more than his father, and at the next, eat nothing. If the parents cannot understand this tremendous variation of intake from meal to meal as being a perfectly normal phenomenon, the child may be prodded or forced to eat more than he wants. Thus is born the frequent complaint of poor appetite at this age. The rebellion of the child may be so great to this prodding and anxiety of his parents that he may become truly malnourished because of a loss of appetite. If the problem is anticipated or caught early, no special measures of correction, other than understanding, are necessary. The child who has no physical illness, but who is truly malnourished due to such a psychological loss of appetite, needs dietary help. Because the appetite is poor we must attempt to furnish these children calories in a concentrated form. Basically, fat is the food best suited for this purpose. At present, even though a number of products are available for supplementation, in my opinion, none of these fulfill the entire need. Much of the value is lost because these supplements must be taken as medicines, and are either refused or taken in quantities too small to help.

Is there not the possibility of providing these calories in the same food the rest of the family is eating? A type of product, that is, which we can bake bread with or add to cooked vegetables—one that, for example, does not single this child out from his siblings or playmates? A type of substance which will allow the child to be eating the same food as the family at regular meal time would be a much more sound psychological approach. Since whatever the child ate in small amounts would be high in calories, the advantage of putting only small amounts of food before the child would also be gained.

The diabetic child often presents the opposite problem. That is, the food that the family eats may contain more calories, especially as free carbohydrate, than is desirable. The tendency to allow children with diabetes to eat "free diets" is gaining popularity fast. This term has many meanings, but in general the diabetic still cannot ingest large amounts of sugar and remain in good control. Education of the family may be accomplished to the end that the entire family, diabetic child included, will eat a diet which is consistent in amounts, but varied in type of food, and will allow excellent diabetic control. Insulin is always used. This family may all eat the low sugar "dietetic" foods and find them palatable. Although many of these foods are available in prepared form, there is still a need for the basic ingredients of this type to be used in preparation of special dishes at home. The removal of free sugar without materially changing the taste, appearance, or consistency of the end product is, of course, the aim.

Many other problems exist and continue to appear as new problems in the management of diets of children. As physicians, we can only suggest these ideas and depend upon your know-how to put them in the hands of the patients.

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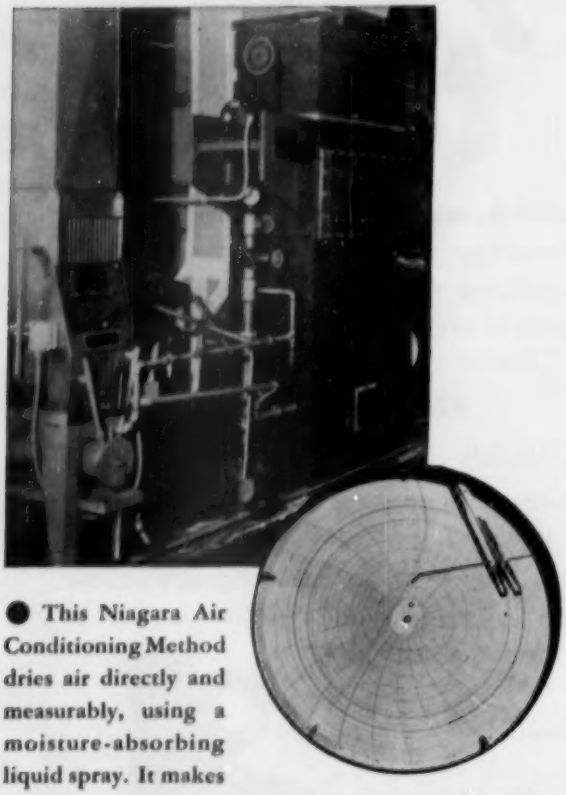

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Robbins, Ralph C.	M.S.	Fate of Tetramethylthiuram Disulfide in the Digestive Tract of the Ruminant Animal
Valdes, Rose Marie	M.S.	Effects of Pretreatment and Type of Packaging Material on Quality of Fresh and Frozen Poultry

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Anderson, Charles A.	Ph.D.	The Heat Denaturation of β-lactoglobulin and α-lactalbumin
Arnott, David R. L.	M.S.	The Effect of Certain Chemical Factors on the Melting Quality of Process Cheese
Cunningham, David K.	Ph.D.	Comparative Studies of the Chemical and Physical Properties of Some Cereal Proteins
Domenigg, Heinz Sorger	M.S.	The Effect of Wheat History on Its Stability Upon Storage
Guy, James	Ph.D.	The Amylases of Milk
Hartley, Clell B.	Ph.D.	A Study of the Cultural and Physiological Characteristics of an Organism Isolated From the Intestinal Tract of a Calf
Hill, Robert M.	Ph.D.	Some Physical Properties of β-lactoglobulin
Hurrell, Clyde O.	M.S.	A Survey of Consumer-Packaged Nonfat Dried Milk Solids
Luchsinger, Wayne W.	M.S.	Studies on the Determination of Low Levels of Lipase Activity
Peterson, Anne M.	M.S.	Studies on the Inhibition of Certain Molds by Lack of Oxygen and Dehydrogenase Activity of Wheat as a Measure of Viability
Prentice, Neville	M.S.	The Effect of Flour Fractions and Various Starches on the Firming of Bread Crumb
Rudnick, Arthur W., Jr.	Ph.D.	Effect of Heat During Processing of Nonfat Dry Milk Solids Used for Cottage Cheese Manufacture
Schlegel, Vera	M.S.	Studies on the Role of Certain Molds in the Deterioration of Stored Wheat and on the Inhibition of Their Growth by Carbon Dioxide
Spriestersbach, David	Ph.D.	The Constitution of Plant Gums
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Cahill, Vern R.	Ph.D.	Effect of Diethystilbestrol on the Carcass Characteristics and Gross Weight of Certain Endocrine Glands of Steers and Bulls
Clements, Robert L.	Ph.D.	A Chemical Study of the Sap of the Sugar Maple "Acer" Saccaren with a Special Reference to the Changes in Composition that Occur in Making Maple Syrup
Crawford, Thomas	M.S.	The Effect of Specific Processing Techniques on the Quality of Sweet Corn
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Davis, Rees B.	Ph.D.	The Effect of Processing Methods on the Color of Canned Tomato Juice
DeWeese, Duane G.	M.S.	The Effect of Varying Storage Periods and Temperatures on the Flavor, Texture, and Color of Raw and Frozen Elberta Peaches
DuVernay, Gilbert	M.S.	Consumer Panel Evaluation of Experimental Foods (Tomato Juice and Cream Style Corn)
Frear, D. Stuart	Ph.D.	A Study of the Intermediates Concerned in Nitrate Reduction in Higher Green Plants
Fritsch, Carl W.	Ph.D.	Autoxidation of Fats and Their Derivatives
Gernon, Gerald D., Jr.	Ph.D.	The Biological Assay of Insecticides in Processed Vegetables
Habib, Ahmed T.	Ph.D.	Physical and Chemical Factors Influencing Color of Potato Chips
Hale, Harold Harlan	M.S.	Disposal of Liquid and Laniated Solid Wastes from Canneries by Spray Irrigation
Hershberger, Truman V.	Ph.D.	Nitrogen Metabolism in the Rumen
Ish, Carl J.	Ph.D.	Electrochemical Properties of an Ion Exchange Membrane
Johnson, Ronald R.	Ph.D.	The Role of Cobalt in the Ruminant Animal
Morr, C. V.	M.S.	Acids Formed by the Heat Treatment of Skimmilk
Raza, Sayeeda	M.S.	A Study in Metabolism of College Students
Schwartz, D. P.	Ph.D.	Lipolytic Enzymes in Raw Skimmilk
Selani, Eva	M.S.	The Effect of Varying the Fat Content and the Type of Flour Mixture on the Quality of Danish Pastry
Vandersall, John	M.S.	The Use of Liver Biopsy Techniques in a Study of Factors Unrelated to Vitamin A intake which Influence Plasma Vitamin A and Carotene Levels

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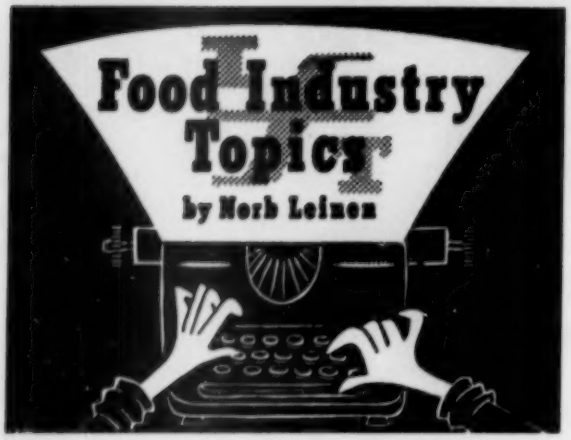

. . . in the public interest

Three of Minnesota's largest industrial firms announced recently that they had entered into a joint undertaking in the field of atomic energy, and expressed the hope that their wide experience will enable them "to evaluate and further nuclear developments of interest to the state and its industries." The companies are Northern States Power Co., Minneapolis-Honeywell Regulator Co., and General Mills Inc. To administer the cooperative undertaking, the firms have set up the Minnesota Nuclear Operations Group. Its primary purpose will be to determine objectives and activities in atomic energy that will be beneficial to the state and Minnesota industry. The group will make recommendations to the member companies regarding methods by which these objectives can most practically be achieved.

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The Glycerine Producers' Association, 295 Madison Ave., New York 17, N. Y., is now accepting nominations for the fourth annual Glycerine Research Awards. First award is $1,000 and an honor plaque, second award, $300 and an honor certificate; and third award, $200 and an honor certificate. Research bearing on the chemical, physical, or physiological properties of glycerine, or of the properties of glycerine-derivatives or glycerine-containing materials is eligible. Work exhibiting originality in extending glycerine's usefulness in new applications will merit special consideration. Nominations must be received by November 1, 1955. For official entry blanks and complete details, write Awards Committee, above address.

◆ ◆ ◆

Manufacturers of chemical specialties are becoming more obligated to warn users that their products, although effective, may be hazardous under certain circumstances. Dr. A. H. Gee, director, Bacteriology and Toxicology, Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y., predicted there may be a rash of complicated state laws which will require precautionary labelling of consumer chemical specialties, including products such as disinfectants, aerosols, and waxes, unless manufacturers take the lead in giving this information voluntarily. He also predicted an increased cost in development of new products. In many cases, laboratory testing will be required before a new product is marketed to see whether it complies with all state laws. Also, for informative labelling of consumer products, toxicological studies will be necessary to anticipate possible consumer hazards.

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Transition to automatic operations in grocery manufacturing will be gradual during the next 10 years. This is the opinion of 75 percent of 40 food company top officials queried in a special survey undertaken by General Foods Corp., White Plains, N. Y. Three out of four executives see automation coming in their own companies, and many commented on benefits to the consumer through improved product quality and lower production costs. Forty-eight percent of executives expect the most change in their firms will be in research and development of new products, while 45 percent expect the greatest change in manufacturing and processing methods. About one in four anticipates large increases in his company's expenditures for research and development, and 63 percent look forward to moderate increases. None anticipates any reductions. More than half believe development of

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Recently Elected Members of IFT

(Continued from page 36)

Milton A. Glaser
99 E. Water St.
Waukegan, Ill.

Dr. Harry E. Gunning
Illinois Inst. of Tech.
Dept. of Chemistry
3300 S. Federal St.
Chicago 16, Ill.

Dr. Carter J. Harrer
Mrs. Tucker's Foods Inc.
Sherman, Tex.

Dale G. Hollenbeck
Box 29
Lodi, Calif.

General T. King
Texas A & M College
Animal Husbandry Dept.
College Station, Tex.

Irwin Kramsky
Farley Mfg. Co.
4820 Searle Pkwy.
Skokie, Ill.

Leo G. Krebs
Poplar Grove, Ill.

Montgomery C. LeGoff
Route No. 3
Rochester, Minn.

Paul A. MacPhee
Southwest Research Inst.
Box 2296
San Antonio, Tex.

James J. McKiernan
194 Sterling Ave.
Yonkers, New York, N. Y.

Dr. William G. Murrell
Div. of Food Pres. & Trans.,
C.S.I.R.O.
Homebush, N.S.W.,
Australia

John B. Seiffhart
3931 Odin Ave.
Kennedy Heights
Cincinnati, Ohio

Clarence G. Sidwell
4841 N. Bell Ave.
Chicago 25, Ill.

Carl B. Smith
c/o Southern Food Products
Co. Inc.
1341 E. Washington Blvd.
Los Angeles 21, Calif.

Dr. Edward E. Smith
J. W. Allen & Co.
110 N. Peoria St.
Chicago 7, Ill.

Paul L. Smith
431 E. Central Ave., Apt. 919
Orlando, Fla.

Dr. James H. Wiegand
446 Furr Drive
San Antonio 1, Tex.

Leonard P. Worthen
3937 N. Mississippi Dr.
Minneapolis, Minn.

STUDENTS

Elizabeth Ann Gardner
Box 1249, Florida State
Univ.
Tallahassee, Fla.

C. Marlin Icenogle
16 Lake Ave.
Lima, N. Y.

Yoshio Tatsukawa
4532-18 Ave. N. E.
Seattle 5, Wash.

atomic science will have a major impact on food processing. Most comments on this subject referred to use of irradiation for sterilization, although quality control, process control, and new process developments also were mentioned.

◆ ◆ ◆

Court action in the form of a protest directed to the Collector of Customs of the Port of New York on behalf of the Southern California tuna industry was filed recently. Accompanying the protest is a statement by Mr. Donald P. Loker, president of the California Fish Canners Assn., that millions of cases of tuna packed in brine are being imported into the U. S., principally from Japan, and the annual flood of this foreign tuna is increasing. Also, that imports of canned tuna into this country last year reached 1,500,000 cases as against a pre-war average of 337,000 cases—an increase of almost 500 percent. New York attorney John G. Lerch, who filed the protest declared the tuna tariff action may have as far-reaching effect as the Schecter "Sick Chicken" case before the U. S. Supreme Court which caused the demise of the NRA. The motion is being filed for an early hearing before the U. S. Customs Court.

. . . things new under the sun

A rapid means for testing the corrosivity of carbonated beverages, which could be correlated with shelf life, has been developed by the Metal Division Research and Development Laboratories of Continental Can Company, 100 E. 42nd St., New York 17, N. Y. Promising applications of this new development, which involves measurement of a current flowing between 2 electrodes immersed in the beverage, have already been made in modifying beverage formulations to give even greater shelf life to canned soft drinks. Continental's Corrosivity Tester has been used also to study the effects of air content. Data accumulated to date confirm the belief that elimination of air in the can headspace will prolong the shelf life of carbonated beverages. The method appears most useful in providing information to estimate with reasonable accuracy when possible perforations from many packs of a certain beverage might occur, assuming normal canning procedures are used and the product is stored under normal conditions. Thus, it is posible to allow a desirable safety factor when estimating the shelf life of a soft drink in any metal container.

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Kojic acid, a uniquely active pyrone, seen as an important base for manufacture of cosmetics, azo dyes, local anesthetics, and in forming metal chelates, is available for the first time in commercial quantities from Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y. To be produced by Pfizer's advanced techniques of fermentation, the product is the

(Continued on page 41)

ACCESSORY NUTRIENT FACTORS

For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77

(Dehydrated) a Complete Culture Medium

FORMULA *Ingredients—when rehydrated on basis of 45 grams per liter of medium.*	
Orange juice serum solids	12.6g*
Agar (dry basis)	15g
Peptone	10g
Yeast hydrolysate	3g
Reducing sugars, total	8g
Sucrose, total	6g
Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

Sunkist Growers

PRODUCTS DEPARTMENT

Exchange

PHARMACEUTICAL SALES · ONTARIO, CALIFORNIA

1955 Exhibits Biggest Ever!

1. **W. F. and John Barnes Company**
   Cortland F. Ames, James Dole Engr. Co.; Marvin Steinberg, Gerald Gernon, Univ. of Ill.; Wallace M. Parry, W. F. and John Barnes, Alvin Nelson, Univ. of Ill.

2. **The Griffith Laboratories, Inc.**
   Leslie W. Hobbs, Chas. M. Harrold, Jr., Chairman St. Louis Section.

3. **H. Kohnstamm & Company, Inc.**
   Joseph P. Tortop, W. H. Nelson, Chicago Mgr.

4. **Sterwin Chemicals, Inc.**
   Velt Stafford, D. Childers, Sue Fearing, K. R. Liggett, Sterwin Chemicals.

5. **Mojonnier Bros. Company**
   Eusebio Vicido, Standard Brands; Joseph A. Cross, Mojonnier Bros.

6. **The Girdler Company**
   Don R. Tucker, Pillsbury Mills; John Bolanowski, Girdler; Leland H. Burt, Hercules Powder.

7. **Monsanto Chemical Company**
   William B. Toulouse, Adv. Mgr., with his family: Tam (Daughter) and Joan (Wife).

8. **Chain Belt Company**
   Marvin H. Janson, Wyeth Labs.; George K. Viall, Vice Pres., Chain Belt Co.

9. **Hoffmann-La Roche, Inc.**
   Verne Littlefield, The Squirt Co.; C. K. Parman, Ralph Christiansen, Hoffmann-La Roche; Fred R. Schumm, Ungerer Co.

10. **Abbott Laboratories**
    John J. Brennen, Sales Rep.; Karl M. Beck, Technical Service, Abbott Laboratories; Howard Walgren, Food Technology Journal.

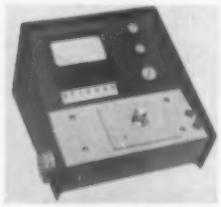
FOOD INDUSTRY TOPICS

(Continued from page 39)

latest in the firm's new series of industrial chemicals made by this process. A comprehensive technical bulletin and samples are available from the company's Chemical Sales Division.

◆ ◆ ◆

A new photoelectric sugar colorimeter designed to **speed, simplify, and standardize white sugar color grading** by sugar producers and users is available from the Beckman Division, Beckman Instruments, Inc., Fullerton, Calif. Result of close liaison between the manufacturer and the U. S. Committee on Sugar Analysis, the instrument will allow maintenance of sugar color control without specially trained personnel or heavy investment in equipment. A small, compact unit, the Beckman colorimeter makes measurements at 420, 560, and 720 mμ, so that either the single-reading method at 560 mμ or the double-reading method at 420 and 720 mμ may be used for color-index checks. Request data file 55.



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The Industrial Odorant Division of Fritzsche Brothers, Inc., 76 Ninth Ave., New York 11, N. Y., has announced perfection of PūTROL, a **new masking agent for putrefaction odor control.** This low-priced, very powerful deodorizing agent is offered as an effective means of controlling the odors of decomposition produced by protein materials. In addition to local city health departments, fat renderers and zoological garden and kennel operations will find this a useful means of controlling unpleasant by-odors. Sample, prices, and literature on this new trademarked item available upon request.

Fritzsche also announces, for those who buy in wholesale quantities, availability of a new, 20-page illustrated Flavor Catalog in which are described more than 30 different flavor groups embracing a total of over 700 varieties of flavors.

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KELON-T (Teflon) tape for food industry use is now available in quantity in widths up to 24" from W. S. Shamban & Co., 11617 W. Jefferson Blvd., Culver City, Calif. The 24" wide tape in thicknesses varying from 0.005" to 0.125" is thought to be the widest continuous length available in production quantities. Non-adhesive and chemically inert, KELON-T tape combines toughness, excellent electrical properties, and resistance to abrasion and corrosive chemicals at high and low temperatures. Because of good elongation, it fits tightly over sharp bends and corners and tends to return to its original shape when heated.

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After months of experimentation, scientists reportedly have produced a **new kind of insecticide** that provides 100 percent control of the new resistant variety of roaches. The new brush-on formulation, SUPER-NO-ROACH, contains organic phosphate compounds. It is claimed to be more effective, longer lasting, and safer than any other roach killer. The liquid is brushed where needed, leaving a residual

CUT SEASONING COSTS

20% to 40%

MAGNA spice concentrols

—scientific formulations of spice essential oils and oleoresins . . . the most concentrated flavoring materials available.

advantages:

- 100% pure, natural products obtained by distillation or extraction from actual leaves, herbs, roots, buds or berries.
- Contain no diluents or inert materials of any kind.
- More economical because they are more concentrated, yet readily diluted in your own plant.

Write for your copy of "Questions and Answers" for the food processor. Learn how the development of Magna Spice Concentrols has modernized the seasoning of food products . . . and cut seasoning costs.

MAGNUS, MABEE & REYNARD, INC.

Since 1895 • One of the world's greatest suppliers of essential oils

16 Desbrosses Street, New York 13, N. Y. • 221 North La Salle Street, Chicago 1, Ill.

FOOD INDUSTRY TOPICS

coating effective for months. SUPER-NO-ROACH kills all 4 varieties of roaches found in America, as well as the resistant strains. The product is manufactured by Gaston Johnston Corp., Long Island City 3, N. Y., and will be available in most stores.

◆ ◆ ◆

The Techniflex Corporation of Port Jervis, N. Y., announces release of its newly designed Water Hammer Eliminator for domestic and small commercial piping. Units are available with ½" and ¾" male I.P.T. connections. The brass and bronze unit takes advantage of the resiliency of seamless convoluted metal hose in combination with the compressibility of the air pocket. The product is available through plumbing supply wholesalers.

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From Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., comes news of **2 new flavors.** Butrnilla, a powdered vanilla product with an interesting buttery note, was developed specifically for ice cream application, for which it is used in a proportion of 8 ounces to 80 gallons. It is equally applicable to powdered milk drinks, desserts, cake mixes, etc. The second flavor, Micronilla Vanrich, is also of interest to ice cream manufacturers, as well as producers of powdered desserts, chocolate coatings, and cake mixes. It is produced by grinding the beans themselves to microscopic particles and then adding various aromatics to enhance odor and taste. Thus, the flavor of the bean is fully realized and not interfered with by solvents or other material necessary to making an extraction. The process is a cold one, and there is no loss of flavor due to heat or exposure.

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A new product—SORTWIK—reportedly enables a person with dry fingers to attain **greater speed in handling and sorting papers and currency.** It eliminates the need for rubber fingers and the unsanitary water-soaked sponge. The product is a hygroscopic preparation—resembling gelatin in appearance—and when applied, by drawing the thumb and forefinger across the material, a thin, tacky film remains on the fingers. It washes off readily. SORTWIK comes in a small, flat container with sliding top, and contains enough material for approximately 4 months' use. Write Lee Products Co., 2736 Lyndale Ave., S., Minneapolis, Minn.

◆ ◆ ◆

A small, compact variable speed stirrer, Model No. 101, is now available in the T-line of high quality stirrers made by Talboys Instrument Corp., 13 Ackerman Ave., Emerson, N. J. It is claimed the Model No. 101 has several features no other stirrer has—it is only 8" high (without paddle), and several used together can replace an expensive multiple stirring unit. It is strong enough to agitate thoroughly over 5 gallons of water. Price is $22.50.

◆ ◆ ◆

Recently announced by Drayer-Hanson, Inc., 3301 Medford St., Los Angeles 63, Calif., manufacturers of air conditioning and refrigeration equipment, is the D-H Flocold Unit Cooler. Three types are available: for room temperatures over 34° F.; for Freon with water defrost; and for ammonia with water defrost for above or below 34° F. temperatures. Over 34° Flocold units are available in 11 models, with BTU capacities ranging from 340 to 4800 per degree F.T.D. Water defrost units are available in 7 models, with BTU capacities ranging from 457 to 3600. Flocolds for ammonia with water defrost are manufactured in 4 models. BTU capacities are from 1200 to 3600.

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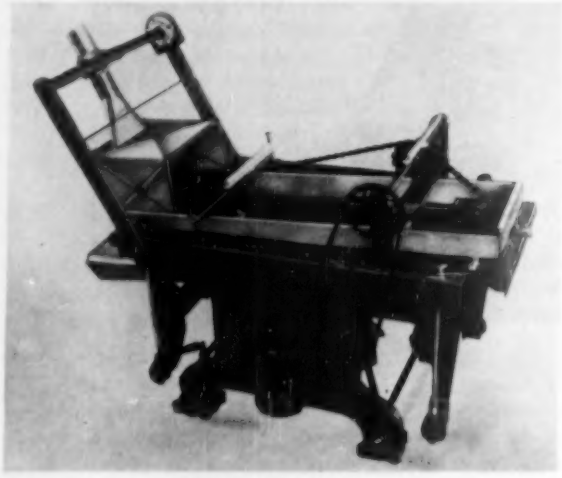

The Russell Separator

The range of gyratory turbulence sifting and straining machines manufactured by Russell Constructions Ltd., Russell House, Adam St., Adelphi, London, W.C. 2, England, is well-known in a number of industries but unusual applications are reported from trades which have to face a **particularly difficult sieving or straining operation.** The special separator machine, with its large rectangular mesh deck, was originally devised for high speed filtering of large quantities of effluent from paper mills, though it is also used for straining ground cocoa masse through a very fine mesh (100-150 holes per inch) or reclaiming coal dust from a slurry (80 mesh). Gyratory turbulence sifters and strainers are a fairly recent innovation, originally having been developed during the war to sieve high explosives. The secret of success lies in the essential smoothness of the operation, and the absence of noise. The effect on viscous materials, not ordinarily considered for fine mesh straining, is such that it reportedly must be seen to be believed.

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Problems of maintaining precise temperatures in a vacuum-evaporation salt manufacturing process have been solved by International Salt Co., Inc., through use of Pittsburgh Corning cellular glass insulation on evaporator tanks and steam piping. International presently is renewing, remodeling, and redesigning the entire evaporation system. Need for efficient insulation plus the material's strength and rigidity, permitting its re-use, were principal reasons for the selection of "Foamglas." For more information on this product, write Ketchum, MacLeod & Grove, Inc., 411 Seventh Ave., Pittsburgh 19, Pa.

A repetitive series of circuit closures can be produced automatically by the compact Model S44 cold-cathode-tube electronic timer of the Farmer CK type. Unless otherwise adjusted, the load circuit remains closed for a fixed time of about 60 milliseconds. The time between circuit closures can be adjusted to any value from as low as 0.03 seconds to 24 seconds. Information available from Farmer Electric Co., 21 Mossfield Rd., Waban, Mass.

◆ ◆ ◆

Quick change-over, ease of cleaning, and high speed are features of a **new, single-piston automatic filler** offered by F. L. Burt Co., 571 Seventh St., San Francisco, Calif. Known as the "Simplex" Table Model A, this semi-automatic filler deposits a given amount of liquid and semi-solid food products into containers and cups.

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The Graver Water Conditioning Co., 216 W. 14th St., New York City, has found, through observation of hundreds of installations, that 4 specific design features of its Reactivator (R), a cold process softener and clarifier, are particularly responsible for its successful response to problems resulting from frequent and fluctuating changes in flow rate and water composition. Two of these features, a variable speed impeller and a separately driven sludge scraper, are mechanical. The other two, non-mechanical, are a low sludge level and sludge removal over the entire bottom of the Reactivator.

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Soft hammers have a wide application in industries to hit or drive metal parts without bruising or marring them. The GS soft hammer mold sells for $24.95, including one reusable metal handle. Additional handles are available for $3 per dozen. For information or trial order, write General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32, Pa.

◆ ◆ ◆

What is believed the **first successful multiple package for glass containers,** featuring easy stacking and protection against breakage, has been introduced by Alford Cartons, Ridgefield Park, N. J. The patented package reportedly permits the glass containers to be safely stacked higher than was possible before, and does not require separate dividers of any sort. No overwrap is needed. The Alford package can be filled by hand, or a jig is available from the manufacturer for setting up the carton.

◆ ◆ ◆

An all-purpose black crepe paper masking tape is available from the Permacel Tape Corp., New Brunswick, N. J. Permacel 717's firm, heat-resistant adhesive holds at normal or forced drying oven temperatures, and releases without adhesive transfer on removal. Its masking range is from 50° to 240° F.

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C^{14}, H^3, S^{35} determinations can be made faster and simpler in a wide variety of applications with the Cary Model 30 Vibrating Reed Electrometer, according to Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif. At Argonne National Laboratory, scientists have developed procedures for converting samples directly to a gas suitable for measurement with an ionization chamber and the Model 30, according to the company report. This simple procedure is said to

WHITE CAKE MIX
CHOCOLATE CAKE MIX
SPICE CAKE MIX
Give your baked goods a fresh new appeal with
GIVAUDAN'S CAKAROMES*
Givaudan's Cakarome concentrates are widely favored among leading bakers and baker's supply houses, for they both enhance and complement true bakery flavor appeal. Offering the highest quality and strength available, Cakaromes are produced in imitation almond, coffee cake, sweet dough, spice cake, pound cake, imitation butter and a large variety of other oven-tested flavors.
Among the many Givaudan flavor products unanimously approved by bakers are flavor bases, citrus oils, fruit extracts for icings, frostings and fillings and such outstanding developments as Permaseal* Flavor Crystals, which provide unique new advantages for many uses.
Our laboratory staff will gladly help you solve your bakery flavor problems.
*Trade-mark
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Inc.
330 West 42nd St., New York 36, N. Y.
Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Atlanta • Seattle • Los Angeles • Toronto

FOOD INDUSTRY TOPICS

eliminate need for use of a precipitate which often is inaccurate, time consuming, and tedious to prepare. Since as little as 10^{-12} curies of radioactivity can be detected, use of expensive "tagged" materials also can be greatly reduced.

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An expanded line of sectional furniture for use in industrial, educational, and institutional laboratories of any size is announced by Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill. Among the items in the line are 4- and 5-drawer units, cupboards, sinks, wall cases, corner units, floor cases, storage dispenser units, fume hood cabinet assemblies, refrigerators, tables, desks, chairs, and stools. A unique feature of the CA furniture line is the availability of scale models of the furniture for visualizing any combination of equipment.

◆ ◆ ◆

A new high shear viscometer has been developed by Hagan Corp., 323 Fourth Ave., Pittsburgh 30, Pa., for testing the flow properties of pigment suspension in the manufacture of paper, as well as paints, printing inks, and in some cases plastics and food. Offering a new approach to the design of rotational viscometers capable of producing high rates of shear, the Hagan Viscometer uses a pneumatic system instead of springs in measuring and recording the shearing force in terms of torque. This system simplifies range changing and does not require disassembly or substitution of components, manufacturer states. It is substantially free of mechanical hysteresis. Its operation is linear, extremely sensitive, and has high speed, low range starting response. Calibration can be verified easily at any time.

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A portable, laboratory model Turba-Film Evaporator for pilot plant study of the unit operations of evaporation, single-step distillation, deodorization, heating, cooling, or other heat treatment is available from Rodney Hunt Machine Co., Orange, Mass. The Evaporator uses Rodney Hunt's unique agitated film method and is provided with a heat transfer area of one square foot. It is designed for use of heating mediums up to 250 psig and 700° F. The Evaporator can be supplied as an individual unit with stand or with auxiliary condensing equipment, or as a complete packaged plant including vacuum, equipment, feed pumps, discharge pumps, and instruments as required.

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Two design features have greatly increased the efficiency of Cesco Permanent Magnetic Ducts in **removal of tramp iron from dry processed products** being conveyed through inclined pipelines. One feature, the 7½° angled face plate, works behind and in conjunction with a flexible baffle, the second design improvement. As a result, all material conveyed through the pipe line is directed across the face plate of the magnet. Smaller ferrous particles are held out of the product flow by a trailing edge on the face plate. Units are available for all pipe sizes from 4" to 16", and in 4 different power models. Write Cesco, Division B38, Santa Rosa, Calif., and request Bulletin No. 322.

◆ ◆ ◆

New "M" Treated Cotton Filter Cloth offers many advantages found in the synthetic fabrics at a cost close to that of untreated cotton filter cloth. It is resistant to many common chemicals, mildew, shrinkage, and wrinkling. The product has been very successful in operations on plate and frame presses and on rotary vacuum filters where the combination of easy cake release, good chemical resistance, and dimensional stability are important factors. Available in chain weaves, hose and number ducks, filter twills, sateens, drills, and flannel from The National Filter Media Corp., 1717 Dixwell Ave., New Haven 14, Conn.

. . . *the literary corner*

The following papers were among those presented at the recent meeting of the Chemical Specialties Manufacturing Assn.: "Applications for Fatty Acids," "Nitrogen Derivatives of Fatty Acids," "Relationship of Use of Fatty Acids to Their Properties and to Analytical Methods," "Storage and Handling of Fatty Acids," "Basic Chemistry of the Fatty Acids." The papers will be printed in the convention proceedings and will be available from the CSMA, 50 E. 41st St., New York City, at a later date.

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Newly revised to include up-to-the-minute information of value to chemists, chemical engineers, and purchasing agents, the 36-page product catalog issued by Eastman Chemical Products, Inc., Kingsport, Tenn., is certain to become a "reference shelf" guide among industries served by the company. The Table of Contents lists acids and anhydrides, alcohols, aldehydes, plasticizers, solvents, amines, phenols, phenol ethers, petroleum additives, and other miscellaneous aromatic chemicals, concluding with information of Eastman's cellulose products and its organic chemicals. As heretofore, the new catalog contains information on warehousing and shipping, and the availability of technical advice and assistance from Eastman's several laboratories.

The firm also has issued a new 8-page booklet describing in detail the typical properties, applications, and compatibility characteristics of Eastman's new polyethylene waxes—Epolene "E" and Epolene "N."

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"Get Perfect Water Clarity with Celite Filtration" is the title of a new 12-page, illustrated brochure by Johns-Manville, 22 E. 40th St., New York 16, N. Y. It covers filtration of potable water, process water, and plant wastes. The brochure explains how Celite diatomite filter aids remove colloids and other suspended impurities; shows the adaptability of Celite powders to various types of filter designs; and cites representative installations where Celite is being used to advantage.

◆ ◆ ◆

Vanilla beans of all origins and qualities continue to be firm at reestablished prices, according to the

June 1955 *Ritter Market Report*, published by F. Ritter & Co., P. O. Box 39696, Los Angeles 39, Calif. The present situation, it notes, indicates no readjustment of prices until the end of the year. The company states that it can offer limited quantities of Pure Vanilla Concentrate 10-Fold at an advantageous price. Quotations upon request. Vanifolia Synten, 10-fold is offered as an excellent substitute for pure Vanilla Concentrate, 10-fold. Made from pure vanilla and other plant extractives with added vanillin, it can be used generally where pure vanilla is not required. Priced at $16.00 per gallon, with special prices on contracts.

◆ ◆ ◆

Labline, Inc. (Chicago Surgical and Electrical Co.), now located at 3070-82 W. Grand Ave., Chicago 22, Ill., sends word concerning the following technical bulletins: No. 4030, on the new CLEAR-VUE Distillator, a stainless steel unit featuring a quarter-turn condenser tube which permits the distillation shield to be set flush with the condenser, permitting unobstructed observation of all receiving flasks; No. 3030, on a new, stainless steel, 450° F. bath for temperature testing, which features double-wall insulated construction, built-in heaters, adjustable thermostat, induction-type motor stirrer; No. SK-124, describing the first high temperature variable speed "Shell" Roll Tester for testing of greases at temperatures up to 750° F., and variable rolling speeds of 0 to 150 RPM; No. SK-109, which explains the facilities and experience of the firm in building special apparatus to customer requirements.

CLEAR-VUE Distillator

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The story of Cransweets—whole, sweetened, processed cranberries—is told in two brochures. One is published by the Wisconsin Alumni Research Foundation (WARF), P. O. Box 2059, 506 N. Walnut St., Madison 1, Wis., the research organization which has been assigned the Cransweet invention. The other is made available by Cranberry Products, Inc., Eagle River, Wis., licensed by WARF to process Cransweets. The product is a development of the Dairy and Food Industries Department of the University of Wisconsin College of Agriculture.

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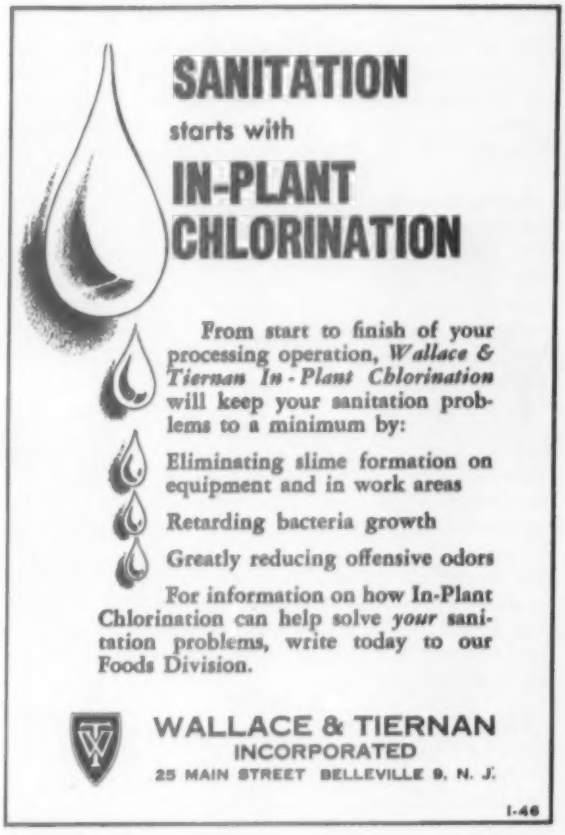
Two brochures, "M&S Fillers by FMC" and "The Sterilmatic Story" are offered by the Canning Machinery Division of Food Machinery and Chemical Corp., P. O. Box 1120, San Jose, Calif., and 103 E. Maple St., Hoopeston, Ill. The first is a 16-page booklet featuring 7 M&S models. A unique chart points out in detail the versatility of the M&S Filler, and its adaptability to the widest range of products handled by any piston-type filler. The second brochure is a 16-page treatise on modern processing as achieved by the FMC "Sterilmatic" Continuous Pressure Cooker and Cooler. It points out the benefits of in-can sterilization with respect to nutrients, color, flavor, and food product quality. Illustrated are the FMC principles of continuous operation and can agitation which assure economical and uniform cooking through fast and even heat penetration.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From start to finish of your processing operation, Wallace & Tiernan In-Plant Chlorination will keep your sanitation problems to a minimum by:
Eliminating slime formation on equipment and in work areas
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Greatly reducing offensive odors
For information on how In-Plant Chlorination can help solve your sanitation problems, write today to our Foods Division.
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INCORPORATED
25 MAIN STREET BELLEVILLE 9, N. J.
I-46

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Penn-Drake White Oils, Petrolatums, and Odorless Solvents are detailed in technical bulletin No. 55, published by Pennsylvania Refining Co., Butler, Pa. Included are specifications and suggested applications for the various products, plus details on the Penn-Drake Custom Refining Service.

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A triple service automatic lubricator that provides continuous, jetting, and cyclic types of lubrication from a single compact unit is described and illustrated in Technical Reference 55A, offered by Bijur Lubricating Corp., Rochelle Park, N. J. Only 9¾" high, this lubricator is particularly adaptable for machinery (such as automatic bar machines and beverage filling and capping machines) which require a variety of oiling methods due to varying mechanical motions.

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A revised 4-page booklet, listing 44 colloidal and semi-colloidal dispersions for operational functions, maintenance, lubrication, machine design, and other industrial applications, has been issued by Acheson Colloids Co., Division of Acheson Industries, Inc., Port Huron, Mich. These products include disper-

FOOD INDUSTRY TOPICS

sions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, and acetylene black. Carriers and diluents are given for each product, along with typical applications and important physical data. Write for "A List of 'dag' Dispersions for Industry."

◆ ◆ ◆

Specially designed Stainless Steel Heat Exchangers have been added to the Young Radiator Co., Racine, Wis., line of standard, fixed tube bundle, shell, and tube heat exchangers. Catalog No. 1155, 4 pgs., provides data on applying these Type "88F" Exchangers for heating or cooling liquids and gases used in chemical, pharmaceutical, refining, and allied processing industries.

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Properties and performance of Dow Corning silicone defoamers are detailed in a 4-page brochure just released. Special attention is given to Antifoam AF Emulsion, said to be the most efficient, versatile, and easiest-to-disperse foam killer on the market. Its parent material, the original Antifoam A Compound, is also described. Suggested concentrations, dispersing media, and application methods are discussed, along with actual working examples in fields ranging from food processing to metal working. Write Dow Corning Corp., Midland, Mich.

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The third new catalog of chemical supplies and equipment offered in less than 6 years, Catalog A-L is obtainable by writing on company letterhead to The Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, O.

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With employee hearing measurement programs of top importance to industry because of recent court decisions, new legislation, and a growing concern over the problem of plant and factory noise, a new booklet just published by Employers Mutuals of Wausau, Wausau, Wis., proves timely and informative. The manual furnishes training and reference material for those learning to operate audiometers to conduct pre-employment hearing measurements. Special emphasis is placed on techniques required in securing accurate data and the proper method of recording findings obtained from the examinations. Write Accident Prevention Dept., above address.

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Technical literature on the new Waco Titrator, 3 new Waco Magnetic Stirrers (jumbo, standard, and junior), and the Waco LO-Temp Bath is available from Wilkens-Anderson Co., 4525 W. Division St., Chicago 51.

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The 1955 SWECO Separator Catalog, published by Southwestern Engineering Co., 4800 S. Santa Fe, Los Angeles 58, Calif., features detailed specifications of equipment now successfully screening over 240 different materials. The firm has collected application data in the food, chemicals, waste and pollution, and other industries. A complete data file will accompany the catalog with information directly pertinent to the interests of each inquirer. Write for Catalog 112-356.

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A 4-page bulletin offered by the Gifford-Wood Co., Hudson, N. Y., describes the firm's new Oscilveyor vibrating conveyor, explains the Oscilveyor's operation, and points out features that make it particularly adaptable for handling flakes, chips, grains, powders, and similar bulk materials.

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Complete engineering and construction services available through the Chemical Plants Division of the Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh, Pa., are explained in new bulletin No. 2505. In addition to the field of general chemicals, the Chemical Plants Division specializes in resins and plastics, fats and oils, chlorine and alkalies, petroleum and petrochemicals, wood utilization, fertilizers, low-temperature processes, synthetic fuels, and special nuclear development work.

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Advantages, uses, and working data for its SAE hydraulic quality low carbon steel tubing are set forth in Bulletin 39, published by Superior Tube Co., 1691 Germantown Ave., Norristown, Pa. The 6-page folder shows, for the first time, a side-by-side comparison of 4 specifications which have been used for pressure applications: SAE, JIC, AMS, 5050 E, and ASTM-A-179. Specifications for Superior's SAE hydraulic tubing also are given.

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A catalog showing the major stainless steel globe valves in the Cooper Alloy line is available from Cooper Alloy Corp., Hillside, N. J. In addition to schematic drawings of the various valves, the booklet includes a section on design factors. Also included is a table of major stainless alloys, giving their designations and applications. Ask for bulletin 55A.

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Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill., offers Bulletin No. 75 on its Moisture Balance, for rapid direct measurement of moisture; Bulletin No. 86A on the Waring Blendor, and Circular No. 1252 on the Cenco cast aluminum bottle stopper clamp.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955

August 15-19	American Society of Agronomy, Davis, California
September 5-7	American Society for Horticultural Science, Michigan State University, East Lansing, Michigan
September 5-9	American Institute of Biological Sciences, Michigan State University, East Lansing, Michigan
September 6-8	Mycological Society of America, Michigan State University, East Lansing, Michigan
September 11-16	American Chemical Society, Minneapolis, Minnesota
September 14-16	American Fisheries Society, Augusta, Georgia
October 19-21	Symposium on Applications of Radioactivity in the Food and Food Processing Industries, Sheraton-Plaza Hotel, Boston, Massachusetts

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

Felton's complete line of FELCOFIX powdered flavors offers you the best answer to the problem of permanently flavoring all kinds of dry, semi-dry or powdered products . . . completely eliminating that old shelf-life bugaboo!

These outstanding flavors are supplied as dry, perfectly homogeneous powders that remain fresh, true and delicious even when used in mixtures containing acids, sugars and other reactive ingredients.

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It will pay you to try our FELCOFIX flavors without delay!

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FOOD INDUSTRY TOPICS

. . . meeting hall and conference room

Over 150 packaging people attended the second annual One-Day St. Louis Packaging Conference, held under auspices of Packaging Institute on May 26 at the Hotel Statler in St. Louis, Mo. Mr. Walter C. George, director of research of Gaylord Container Corp., St. Louis, acted as chairman. Following addresses by industry leaders and packaging specialists, the audience was given its choice of attending one of two afternoon panel seminars—on "Bulk Packaging," and on "Merchandising through Better Packaging." The Packaging Institute is headquartered at 342 Madison Ave., New York 17, N. Y.

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A Symposium on Applications of Radioactivity in the Food and Food Processing Industries, to be held at the Sheraton Plaza Hotel, Boston, October 19-21, 1955, is announced by Tracerlab, Inc., 130 High St., Boston 10, Mass. The firm's Technical Division is sponsoring the Symposium—second in a series on industrial applications of radioactivity. Primary objective will be to acquaint members of the food and food processing industries with past uses and possible future applications of radiosotopes in research, development, and process control. The first day will be devoted to orientation talks directed to persons contemplating use of radioisotopes. The second and third days will be taken up by presentation of technical papers by speakers from industry, academic research institutions, the Atomic Energy Commission, and other governmental agencies. For further information and registration form write the Technical Division's Symposium Committee at the above address.

. . . building up and branching out

Entering an entirely new field which offers vast possibilities, H. J. Heinz Company has announced a line of geriatric products specially processed to meet the diet requirements of older people. The products—representing an important "first" in the food industry—will be marketed as "Senior Foods." High in protein, calcium, and iron content and low in calories, the line is produced with no salt added. First items, produced after 5 years' research, will be Beef Stew, Lamb Stew, and Chicken Stew. Other products are expected to be added, together with a selection of desserts especially designed for taste and nutritional values. Market tests will be started shortly in Cincinnati where population studies show a large percentage of population in the 60-and-over class. The second test market likely will be St. Petersburg, Fla. Following these tests, Heinz expects to begin national distribution of the new line.

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Intensifying its instrument sales engineering coverage, The Foxboro Company, Foxboro, Mass., has established 10 regional sales divisions, with territories arranged for maximum service to industrial instrument users. Administered by Mr. H. I. Ehrisman, newly appointed general sales manager, and Mr. J. J. Burnett, field sales manager, the new regional structure will permit full utilization of the firm's 48 branch offices in serving the needs of industry. The 10 new offices and managers are: New England, H. H. Michelmore; New York, E. R. Huckman; Philadelphia, J. B. Deaderick; Pittsburgh, A. H. Shafer; Atlanta, E. W. Prendergast; Cleveland, H. L. Lee; Chicago, J. J. Connelly; Dallas, E. L. Stark; Houston, L. W. Parten; and San Francisco, R. E. Rogers.

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Patent No. 2,708,157, covering an additive designed to give a new appearance and improved performance characteristics to the abrasive cleanser formulas used in kitchen and bathroom sanitation, has been granted to IFT member Alfred C. Houser, vice president and account executive with Lloyd M. Rosenow, Inc., advertising agency, 608 S. Dearborn St., Chicago. The product, named Sky Dust, is a blue silicate which is said to provide tracer color for the cleaning job, enabling the user to determine when all of the cleanser has been flushed away. The invention is designed to eliminate the gritty residue frequently left with present cleansers and to provide additional polishing action. The method of marketing the product is as yet under consideration.

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The first nationwide public relations campaign to promote use of pure vanilla extract is being started in this country by Madagascar vanilla growers, according to Mr. Pierre L. Massin, the representative of French Overseas Territories, in New York City. Aim of the program will be to increase use of pure vanilla extract in the home and to win back some of the food manufacturing market the pure product has lost to imitations. The program will be sponsored by the Vanilla Growers Assn. of Madagascar with the cooperation of the Vanilla Bean Assn. of America. Bernard L. Lewis, Inc., Empire State Bldg., New York City, public relations firm specializing in the food field, has been retained to handle the program.

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The Alfred Jorgensen Laboratory for Fermentation, Copenhagen, Denmark, announces appointment of the Paul-Lewis Laboratories, Inc., Milwaukee, Wis., as its distributor of pure yeast cultures for North and Central America. The Jorgensen Laboratory is reportedly the first in the world to specialize in preparation and supply of pure yeast cultures. The laboratory was founded in 1881. The large collection of brewing yeast strains is described in a catalog available from the Paul-Lewis Laboratories in which various properties of interest to breweries are listed.

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Bostitch, Inc., 1025 Mechanic St., Westerly, R. I., pioneer manufacturers of staples and stapling machines widely used in the food and frozen food fields, will move its main manufacturing plant and general offices to East Greenwich, R. I., where a new and larger factory will be built. The move is due to heavy production demands resulting from a 450 percent sales increase since 1945.

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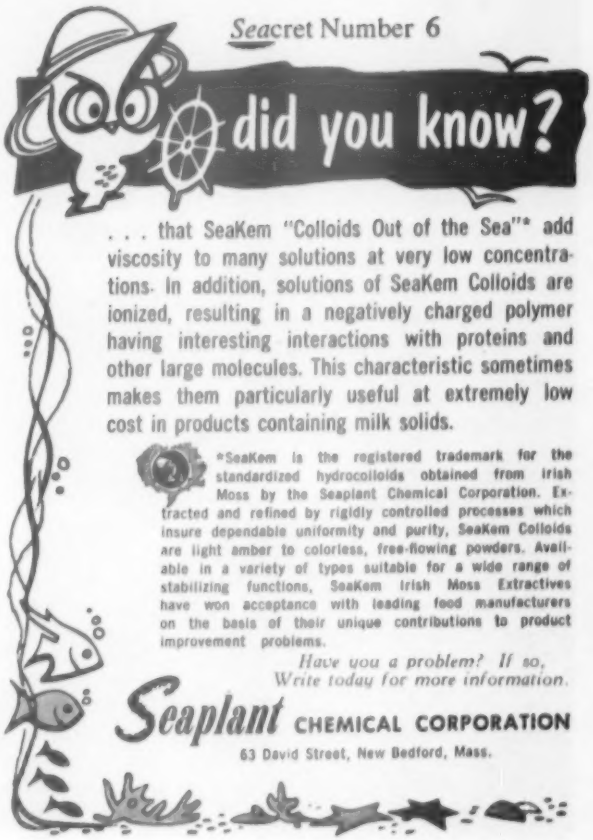
Establishment of Nuclear Magnetics Corporation as a new subsidiary of The Perkin-Elmer Corp., Main

Advertisers' Index

	Page
Abbott Laboratories	11
Ass'n of American Soap & Glycerine Producers, Inc.	3rd Cover
Atlas Powder Company	27
Diamond Crystal Salt Company	5
Distillation Products Industries	14 and 15
Felton Chemical Company, Inc.	47
Florasynth Laboratories, Inc.	31
Food Development Laboratory	52
Food Machinery & Chemical Corporation	1
Food Research Laboratories, Inc.	52
The Foxboro Company	28
Fritzsche Brothers, Inc.	13
Givaudan Flavors, Inc.	43
Griffith Laboratories, Inc.	21
Hoffmann-La Roche, Inc.	2
Johns-Manville Corporation	35
Klenzade Products, Inc.	36
H. Kohnstamm & Company, Inc.	19
LaWall & Harrisson	52
Magnus, Mabee & Reynard, Inc.	41
Merck & Company, Inc.	17
Monsanto Chemical Company	37
Morton Salt Company	33
Neumann-Buslee & Wolfe, Inc.	9
Niagara Blower Company	32
Norda Essenial Oil & Chemical Company	4th Cover
Chas. Pfizer & Company, Inc.	7
Rohm & Haas Company	3
Schwarz Laboratories, Inc.	52
Seaplant Chemical Corporation	49
A. E. Staley Mfg. Co.	51
Sterwin Chemicals, Inc.	23
Sunkist Growers, Inc.	25 and 39
Takamine Laboratory, Inc.	29
van Ameringen-Haebler, Inc.	2nd Cover
Wallace & Tiernan Company, Inc.	45
Wisconsin Alumni Research Foundation	52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. . . that SeaKem "Colloids Out of the Sea"* add viscosity to many solutions at very low concentrations. In addition, solutions of SeaKem Colloids are ionized, resulting in a negatively charged polymer having interesting interactions with proteins and other large molecules. This characteristic sometimes makes them particularly useful at extremely low cost in products containing milk solids.
*SeaKem is the registered trademark for the standardized hydrocolloids obtained from Irish Moss by the Seaplant Chemical Corporation. Extracted and refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem Colloids are light amber to colorless, free-flowing powders. Available in a variety of types suitable for a wide range of stabilizing functions, SeaKem Irish Moss Extractives have won acceptance with leading food manufacturers on the basis of their unique contributions to product improvement problems.
Have you a problem? If so,
Write today for more information.
Seaplant CHEMICAL CORPORATION
63 David Street, New Bedford, Mass.

Ave., Norwalk, Conn., has been announced by Mr. Richard S. Perkin, president and board chairman of Perkin-Elmer. The newly-formed corporation will maintain executive offices and research and development facilities in Boston. Manufacturing operations will be transferred to the parent company's plant in Norwalk. Nuclear Magnetics will market a complete line of nuclear magnetic resonance equipment. It has purchased complete rights to the NUMAR line from Laboratory of Electronics, Inc., Boston, designers and manufacturers of electronic equipment.

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The Seymour Packing Company, Topeka, Kansas, one of the country's largest manufacturers and processors of egg and poultry products, has changed its name to Seymour Foods, Inc., according to announcement by Mr. Harold J. O'Connell, board chairman. Principal purpose of the change is to clarify the nature of the firm's operations. Under the new name, Seymour Foods, Inc., will continue to process poultry and egg food products, marketed primarily to manufacturers of complete cake mixes.

. . . *the human element*

Mr. Andre Givaudan, a director of L. Givaudan & Cie., S.A. of Geneva, Switzerland, and its affiliated organizations, left the U. S. on May 23 for Paris after completing his semi-annual visit to this country. He had arrived here on May 9 and attended the convention of the Toilet Goods Assn. where he renewed acquaintances and discussed industry problems with his many American friends.

Mr. Hans P. Kessler, sales manager of Givaudan Flavors Inc., New York City, informs us that **Mr. Townsend J. Sausville** has joined the firm's sales staff as representative in the New York-New Jersey area.

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According to announcement by Mr. Stuart Goodwillie, general sales manager of Ungerer & Co., 161 Avenue of the Americas, New York City, **Mr. Wm. A. Arko** and **Mr. Frank A. Ball** have been appointed sales representatives. They will be located at the Chicago District Sales Office and will report directly to Mr. J. L. Slais, Chicago manager.

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Dr. Milton E. Parker, director of food engineering at the Illinois Institute of Technology, Chicago, Illinois, is one of the organizers and the president of the newly formed Sea Products Corporation of New Bedford, Massachusetts. By means of a new process whereby trash fish combined with whey are converted to an animal feed supplement high in growth factors, the firm plans to utilize in their enterprise the various varieties of trash (industrial) fish available in the fishing grounds of the New England Coast. Additional products are expected to be added, for example, pharmaceuticals, as the research phase of the business is developed. Plans for a commercial plant in New Bedford are already under way. Professor Parker and his associates are currently evaluating the industrial fish

(Continued on page 51)

CHARLES R. COX

Portrait by Fabian Bachrach

"I urge every executive..."

"I know of no better method for each citizen to protect the American way of life than by building his own economic security and by helping his Government to keep financially sound. Both these results can be accomplished through the Payroll Savings Plan. I urge every executive in the nation to give this Plan his active and vigorous support."

CHARLES R. COX, *President, Kennecott Copper Corporation*

With the active cooperation of Mr. Cox, Kennecott conducted a person-to-person canvass which put a Payroll Savings Application in the hands of *every* one of Kennecott's 20,000 employees. The men and women of Kennecott did the rest. Country-wide participation in Kennecott's Payroll Plan rose from 24% to 52%.

Your State Director, U. S. Treasury Department, is ready to help you install a Payroll Savings Plan, or show you how to build participation in an existing Plan through a simple person-to-person canvass. Write today to Savings Bonds Division, U. S. Treasury Department, Washington, D. C.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

THE INSTITUTE OF FOOD TECHNOLOGISTS

FOOD INDUSTRY TOPICS

(Continued from page 49)

available in New Bedford and obtaining the engineering data necessary for planning the layout and equipping the proposed plant. It is anticipated that operations will begin in 1956, but the precise date cannot be predicted at this time.

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The Pfaudler Co., Rochester, N. Y., announces appointment of **Mr. Chas. M. Fletcher** as manager of its Philadelphia Regional Office, serving Eastern Pennsylvania, Delaware, and Southern New Jersey. Prior to this appointment, he served as sales engineer for the Connecticut area.

The company also announces address changes for its New York and Southwest Regional Offices. The former is now located at 33 Newark St., Hoboken, N. J. A. Gusmer, Inc., sales representatives for Pfaudler's Schock-Gusmer Division, is also located at the new address. The Southwest Regional Office has moved from Dallas to 514 W. Main St., Houston, Texas.

◆ ◆ ◆

Mr. Spencer S. Meilstrup, general sales manager of the Diamond Crystal Salt Co., St. Clair, Mich., announces the following promotions: **Mr. Robert J. Martini** to Chicago district manager; **Mr. Wm. J. O'Connell** to replace Mr. Martini as district manager in Cincinnati; **Mr. Chas. A. Dewhurst** to district manager in Detroit; and **Mr. John C. Chatley** to associate sales promotion manager.

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Mr. Sydney N. Stokes has been named to the new post of assistant to the executive vice president of van Amerigen-Haebler, Inc., manufacturer of perfume materials, flavors, and chemicals. He assumed his new duties on August 1, according to Mr. Chas. P. Walker, executive vice president. Mr. Stokes has been with Merck & Co., Inc., for the past 21 years in various executive capacities.

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Mr. James H. Beaumont has been named director of public relations of the A. E. Staley Mfg. Co., Decatur, Ill., corn and soybean processor, according to announcement by Mr. A. E. Staley, Jr., president. Mr. Beaumont, with the *Decatur Herald and Review* editorial department since 1926, and city editor of the *Review* for the past 9 years, succeeds Mr. Harold J. Roche, who resigned in May to return to newspaper work in Madison, Wis.

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Mr. Latane De S. Lamb has been named technical sales representative for Atlas Powder Company in the Houston, Texas, area, succeeding Mr. Allen V. Riley who died on June 10.

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Mr. Wm. Franklin Fischer, retiring general sales manager of Magnus, Mabee & Reynard, Inc., international essential oil firm, was honored by company executives and friends from the candy and other industries, and by members of the trade press at a dinner held at the Manhattan Club, New York City, on May 31. On presenting Mr. Fischer with a gift of appreciation from the Board of Directors, Mr. Percy C. Magnus, president, said that Mr. Fischer was the oldest member of MM&R, in terms of length of service, having started as office boy in 1907.

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Mr. Frank F. Elliott has become president of Crane Company, Chicago, replacing Mr. John L. Holloway.

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Two local USDA scientists were honored by the Department recently in Washington for their research in agricultural chemistry. Both are staff members of the Eastern Utilization Research Branch's laboratory in Wyndmoor, Pa. **Dr. Daniel Swern** received the Department's highest award—the Distinguished Service Award, consisting of a gold medal and a citation. **Dr. Monroe E. Wall** received the Superior Service Award of a silver medal and a citation. The awards were made by Agriculture Secretary Ezra T. Benson.

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Mr. Wm. H. O'Shaughnessy has been appointed assistant market analysis supervisor for the Olin Film Division of Olin Mathieson Chemical Corporation, it was announced by Mr. A. T. Safford, Jr., sales manager. The Film Division manufactures Olin Cellophane and Olin Polyethylene, both used in packaging bakery products, foodstuffs, apparel, and domestics.

◆ ◆ ◆

Executive vice president **Wm. P. Drake** succeeded **Mr. Geo. B. Beitzel** as president of the Pennsylvania Salt Mfg. Co., Philadelphia,

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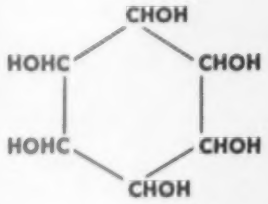
... for Chemical Synthesis and Lipotropic Preparations



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A recognized member of the B-Complex vitamin group, Inositol has several applications in the pharmaceutical industry. It is used either alone or with certain vitamins, as a lipotropic agent. The six hydroxyl groups in the molecule lend themselves to esterification and ether formation. And Inositol is also used in chemical synthesis. It is a product that holds great promise, not only for medicine, but for many fields of industry.

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For information about other quality Staley pharmaceutical products; Corn Steep Liquor, Corn Syrups, Amino Acids, Starches, Lecithin, etc., write:

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DECATUR, ILLINOIS

FOOD INDUSTRY TOPICS

Pa., on July 1. Mr. Beitzel will continue his association with the firm as a board member and, in addition, will serve as chairman of the board of the Pennsalt International Corp., a subsidiary. At 42 years of age, Mr. Drake is the youngest president in Pennsalt's 105-year history, and with 21 years' service prior to assuming office, has longer company experience than all but one of his 13 predecessors.

PUBLICATION OF LOCAL SECTION PAPERS OF TECHNICAL MERIT

Good technical papers, worthy of publication in FOOD TECHNOLOGY as articles or, in condensed form, as contributions to "Notes and Letters" are presented from time to time before local sections of IFT. The Committee on Publications has suggested that the program committee of local sections urge authors of such papers to submit copies to the Editor of FOOD TECHNOLOGY for review and possible publication.

Inquiries concerning local section papers are often made, and it is apparent that FOOD TECHNOLOGY would be performing a useful service by publishing acceptable papers from these sources. Although it may not be possible to publish all papers received, every effort will be made to accommodate those that meet journal standards.

EMPLOYMENT NOTICES

WANTED: Home Economist for research and product development with egg solids. Customer contact work will be required. Appearance and personality are important. Send complete detail of training and experience together with a photograph. REPLY BOX 421, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist, Ph.D., minor in Biochemistry and Bacteriology with 3 yrs. exper. in research, 1 yr. in quality control lab. Desires position in research or quality control with progressive organization in food field. REPLY BOX 429, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

FOOD TECHNOLOGISTS

An active, confidential service: Interview at your convenience, Call, write or wire:
Gladys Hunting (Consultant)
Drake Personnel, Inc.
Room 628
HArrison 7-8600
220 S. State St., Chicago 4, Ill.

WANTED: By container manufacturer, young man with B.S. in Chemistry, Chemical Engineering or Food Technology for customer research and quality control work. Higher degrees while acceptable are not necessary. Experience in container manufacture, cannery or related work helpful. REPLY BOX 428, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist, Ph.D., '53. Major Food Technology, Minors Food Microbiology and Chemistry. 4 yrs. research exper. and 2 yrs. practical exper. Publications. Desires position in research, teaching, product control. Age 32, married. REPLY BOX 427, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist, experienced in fountain toppings and ice cream flavors to take charge of laboratory, quality control and new product development in old established company. Supply full details training and experience. REPLY BOX 425, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: ADMINISTRATOR—FOOD TECHNOLOGIST, B.S., M.B.A. 33, married, veteran. Thoroughly familiar with all phases of production and quality control, product development, sanitation, cost studies. 8 yrs. exp. Presently Assistant General Manager food processing firm. Will relocate. REPLY BOX 426, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Recent graduate, organic or analytical chemistry major, with minors in Biological Sciences, Mathematics and/or Food Technology. Involves quality control, technical services and research and development on food products not in category of cereals or canned goods. REPLY BOX 430, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Plant Food Technologist. A large eastern packer of fruits and vegetables has an opening for a Food Technologist to take charge of quality work in one of our branch freezing plants. This position requires a minimum of two to four years practical experience.

This job is a challenging one and offers opportunities for advancement. If interested, please send complete details of your experience and your salary requirement to BOX 423, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist - Management position canning or freezing. Have graduate degrees Food Technology. 17 yrs. exp. includes plant and lab work, management of production and research in processing and packaging of fruits, vegetables, meat and dairy products. Also experienced in development and production operation of aseptic canning. REPLY BOX 422, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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Announcing the 1955 Glycerine Research Awards

FIRST AWARD	**Honor Plaque**	**$1,000**
SECOND AWARD	**Honor Certificate**	**$300**
THIRD AWARD	**Honor Certificate**	**$200**

The purpose of this group of awards, established in 1952 by the Glycerine Producers' Association, is to recognize and encourage research leading to new and improved applications of glycerine or glycerine derivatives to products or processes. The work may concern itself with the chemical, physical or physiological properties of glycerine, or with properties of glycerine-containing or glycerine-derived materials. It may deal with applications which of themselves are currently or potentially of value to industry or the general public, or it may deal with scientific principles or procedures likely to stimulate future application. Originality in extending the application of glycerine into new fields of usefulness will receive special consideration for awards.

BASIS OF ENTRY

These awards are open to any individual in the United States and Canada engaged in research, whether employed in industry or affiliated with a governmental or educational institution (faculty or college student) except those connected with member companies of the Glycerine Division, Association of American Soap & Glycerine Producers, Inc., or laboratories which they employ. (Joint entries by research teams or associates of two or three individuals are also eligible.)

PERIOD OF AWARD

First consideration for the 1955 Award will be given to work which has come to a successful conclusion or clear-cut point of accomplishment during the current year, regardless of the date at which the work was initiated. Work carried on in previous years, but the significance of which has been confirmed by commercial application in 1955, will be eligible.

JUDGES

Selection of award winners will be made by a committee of three judges of outstanding reputation and appropriate scientific background, having no connection with the Association or its members.

DATE FOR NOMINATIONS

All nominations for the 1955 awards must be received by *November 1, 1955.*

METHOD OF NOMINATION

Only nominations made on the official entry blank will be eligible for awards. For a copy of this official entry blank, write to: *Awards Committee, Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.*

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